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THE CANADIAN TRANSCONTINENTAL RAILWAY COMMISSION.

At the present time when the subject is being discussed whether the work of constructing the Panama Canal should be carried on under direction of a commission, it is of interest to note that the Dominion of Canada has recently placed in the hands of a commission the entire work of constructing a railway from Winnipeg, Manitoba, through the forests north of the Ottawa to Quebec and thence to a terminus on the Atlantic Coast at Moncton, New Brunswick. The total distance to be covered is about 1,900 miles and an expenditure of at least $65,000,000 will be involved. The project was fully described in our issue of Oct. 22, 1903.

The accompanying engraving, reproduced from a group photograph recently taken at Ottawa, shows the four members of the Transcontinental Railway Commission, with their Secretary and Chief and Assistant-Chief Engineer.

The four commissioners represent the four Canadian Provinces chiefly interested in the construction. Mr. F. B. Wade, of Halifax, N. S., the Chairman, representing the Maritime provinces; Mr. Alfred Brunet, representing Quebec; Mr. Robert Reid, of London, Ont., representing Ontario; and Mr. Chas. A. Young, Manitoba. The Chief Engineer, Mr. H. D. Lumsden, formerly held a prominent position on the Canadian Pacific engineering staff, and Mr. M. J. Butler, the Assistant-Chief, has been for 20 years a member of the American Society of Civil Engineers and has had an extensive experience in many lines of railway work, having recently been Chief Engineer of the Locomotive & Machine Company of Montreal.

THE TRANSCONTINENTAL RAILWAY COMMISSION OF CANADA.

(Those standing, beginning on the left, are Messrs. M. J. Butler, M. Am. Soc. C. E., Assistant Chief Engineer; Robert Reid, Commissioner, London, Ont., and Alf. Brunet, Commissioner, Quebec. Those seated are: P. E. Ryan, Secretary; Chas. A. Young, Commissioner, Manitoba; F. B. Wade, K. C., Chairman of Commission, and H. D. Lumsden, Chief Engineer.)

DEVELOPMENT OF A GREAT WATER POWER on the St. Louis River near Duluth, Minn., is again under consideration and a corporation known as the Great Northern Power Co. has been organized to carry out the enterprise. The initial installation will be of about 30,000 HP., but over 100,000 HP. can be obtained when the demand for power warrants.

THE FIRST ANNUAL REPORT OF THE ISTHMIAN CANAL COMMISSION.

On Jan. 13, as we briefly noted last week, President Roosevelt transmitted to Congress the first annual report of the Isthmian Canal Commission. The report as now published is a pamphlet of 93 pages and is accompanied by a separate supplemental report of Major-Gen. Davis, who by reason of his continuous residence on the Isthmus took no part with the other members of the Commission in the preparation of the report itself. We have endeavored in what follows to bring into permissible limits of space those portions of the report of most immediate interest to engineers:

The report first quotes the Federal law authorizing the construction of a canal at Panama, approved June 28, 1902; the treaty with Panama ratified Feb. 23, 1904; the Act of April 28, 1904 providing civil government for the Canal Zone and the President's instructions to the Commission, dated May 9, 1904.

The property of the New Panama Canal Co. of France was turned over to the United States on May 4, 1904, and was formally received by Lieut. Mark Brooke, Corps of Engineers, U. S. A., who by direction of the Commission continued the work in progress at Culebra and elsewhere with the same working force until the arrival of Gen. Davis, Military Governor of the Zone, on May 17. Gen. Davis placed the work in charge of Maj. W. M. Block, and it was thus carried on, substantially as had been done under the French administration, until the arrival of the Chief Engineer, Mr. John F. Wallace, in the latter part of June. The report of the Commission then continues as follows:

ORGANIZATION.

The Commission holds a relation to the canal construction work similar to that of a board of directors to a great railway enterprise, except that the Commissioners are in closer touch with their work, and the majority being civil engineers, stand in the relation of consulting and designing engineers to the canal work. The affairs of the Commission are conducted by the Commissioners acting as a body in frequent meetings. These meetings are generally held either upon the Isthmus or at Washington. There have been 30 meetings held on the Isthmus, 27 at Washington, and 2 at New York.

At its Washington office are stationed the Commission secretary, the general counsel, the chief disbursing officer or treasurer, and the auditor. On the Isthmus are the engineering department, the material and supplies department, and the government of the Canal Zone. The Commission also maintains there a disbursing office and will maintain a branch of the auditor's office.

The Commission has recently subdivided its work among committees which, as originally appointed, were as follows:

Committee on Engineering plans.—The engineer members of the Commission: Mr. Harrod, chairman, Mr. Burr, Mr. Grunsky and Mr. Parsons.

Executive Committee.—Mr. Parsons, Mr. Grunsky, Admiral Walker.

Committee on Engineering.—Mr. Burr and Mr. Parsons.

Committee on Finance.—Mr. Hecker and Mr. Harrod.

Committee on Legislature.—Mr. Harrod and Mr. Hecker.

Committee on Sanitation.—Mr. Grunsky and Mr. Burr.

The chairman of the Commission is ex-officio a member of these committees, and General Davis is a member thereof when meetings are held on the Isthmus.

There is at present one vacancy on the Commission and on some of the above-named committees, Col. Frank J. Hecker having resigned on Nov. 16.

The governor of the Canal Zone represents the Commission in all matters relating to Canal Zone affairs and land matters, and supervises the operations of the health department. Maj.-Gen. George W. Davis, U. S. Army, a

member of the Commission, was appointed governor on June 8, 1904. His executive secretary is Mr. Harry D. Reed.

Hon. Osceola Kyle is judge of the Canal Zone, Mr. J. M. Keedy, prosecuting attorney, and Mr. Tom M. Cooke, collector of revenue.

On May 6, 1904, Mr. John Findlay Wallace was elected chief engineer of the Commission, and assumed his duties on June 1, 1904. The chief engineer has been placed in charge of the Commission's engineering work, of canal construction work, of the construction of water-works and sewerage systems for Panama and Colon, and, under the direction of the governor, he has charge of the construction and repair of buildings and of Canal Zone public works.

The engineering staff includes the following: Mr. John Seager, secretary to the chief engineer; Mr. W. J. Karner, office engineer; Mr. Carleton E. Davis, engineer in charge of water-works and sewerage; Mr. Walter E. Dauchy, division engineer; Messrs. H. F. Dosé, Boyd Ehle, Charles List, A. C. Harper, H. W. Durham and E. W. Clark, resident engineers; Messrs. A. B. Nicol and W. B. Ruggles, assistant engineers; Mr. M. O. Johnson, supervising architect; Mr. George D. Brooke, member board of appraisal; Mr. Carl E. Strom, chief mechanical engineer.

Mr. E. C. Tobey, paymaster U. S. Navy, is the chief of the material and supplies department. This department is directly under the Commission, but subject to the requirements of the chief engineer as well as of the governor of the Canal Zone.

FIRST VISIT OF THE COMMISSION TO THE ISTHMUS OF PANAMA.

The full Commission first arrived on the Isthmus on April 5, and established provisional headquarters in the buildings erected for the residence of Mr. De Lesseps.

During this visit the Commission occupied itself thoroughly with a study of the plans and methods of work as then carried on by the New Panama Canal Co. and with an examination of the physical conditions of the proposed canal route and of the adjacent territory.

At the time of this visit the only work in progress was the excavation of the Culebra Cut through the divide between the two oceans. The outfit here consisted of a few French steam excavators and dump trains and a force of about 700 men engaged in blasting, loading cars, removing the excavated material from the track and down the slopes of the fill. Neither the equipment nor the organization of the force could be considered as adequate, or in any way fitted for the prompt removal of the great mass of material in the cut.

It was, however, considered advisable, when the Commission assumed control, to continue the employment of the existing force and tentatively to introduce changes of organizations and an increase of equipment. The retention of the labor already acclimated, and, in some degree familiar with the work, was very desirable.

From the examination which the Commission was enabled to make during this visit of the studies under the two French canal administrations, of their plans and of the physical conditions of the Canal Zone, it was evident that new and extended surveys and examinations were required before conclusions could be reached in many of the most important problems of location and construction presented by a canal of the character and dimensions now proposed by the United States.

Among the objects of continuation of surveys by the Commission may be mentioned the determination of the practicability of a sea-level canal from the point of view of the greater cost and time required for its completion. Connected with this is the possibility of constructing a storage dam at Gamboa, and of wasting, from the lake above, the surplus discharge of the Chagres River.

If full investigation should show the impracticability of a sea-level canal the information necessary to decide on a summit level and the location and number of locks required for a high-level canal must be acquired by further surveys. Other questions, still unanswered, are the possibility of a dam at Gatun to extend the length of open navigation, the relative advantage of the low-level or Tiger Hill route from Bohio to Gatun, and the Caribbean entrance to the canal at Cristobal.

Under these conditions it seemed to the Commission that the step which at that time would most effectually contribute to the progress of the work was the immediate organization of surveying parties to procure all information bearing on these and other problems. To carry out this object the Commission returned to the United States on April 29.

HARBOR AT CRISTOBAL.

The problem of a suitable interior harbor at the Colon terminus of the canal was never completely solved by either the Old Panama Canal Co. or the new. This harbor is of special importance from the fact that it must be the point of delivery of a large portion of the plant and material required in the construction of the canal. One engineering party, therefore, was assigned to this work, and its investigations have now been so nearly completed that the development of the final plans for both the deep-water channel and the inner harbor, including about a mile of the canal line immediately within the entrance, will be concluded within the next two or three months.

PROPOSED DAM AT GATUN AND TIGER HILL ALTERNATIVE.

A second party of engineers was assigned to the work of making surveys and investigations including borings in the vicinity of Gatun, about 5 miles from the Colon end of the canal, with a view to securing data in connection with a possible dam across the Chagres River at that point. The valley of the Chagres is somewhat less than a mile wide at Gatun, and there are outcroppings of soft rock within the limits of the floor of that valley. Question has been seriously raised as to the practicability of building a dam across the Chagres River at this point so as to form a lake possibly 20 or 25 miles long and thus avoid the necessity both of building a dam at Bohio and of excavating the canal prism between Gatun and Bohio. The same engineering party is making examinations by surveys and borings of an alternative line for the canal between Gatun and Bohio by way of Tiger Hill, a distance of about 12 miles. This proposed relocation would save about 1¼ miles in distance and would remove the canal line farther away from the Chagres River on to somewhat higher ground. That removal, however, would necessitate carrying the canal within embankment of considerable height in soft ground and it would destroy the availability of a large amount of canal excavation made by the Old Panama Canal Co. between Colon and Bohio. This work of investigation along the alternative Tiger Hill line is nearing completion and the requisite data for finally determining the location of this portion of the canal line will be available to the Commission in the near future.

The force having in charge the surveys and examinations on the alternative line between Bohio and Gatun is also making further investigations relating to a possible site for a dam across the Chagres Valley at some intermediate point between those limits. While it is scarcely expected that these investigations will result favorably to such a construction, the outcrop of rock at a number of points has prompted the Commission to secure all possible information of this character.

BOHIO DAM.

The plans of the New Panama Canal Co. as far as developed, and the tentative plans of the former Isthmian Canal Commission, contemplated a great dam across the Chagres River near Bohio, about 17 miles from Colon, at the head of the Caribbean tide-level section of the canal. A considerable amount of investigation work has therefore been done at and in the vicinity of this site by both the New Panama Canal Co. and the former Isthmian Canal Commission, but far more by the latter than the former. The probable construction of this dam for the purpose of forming a summit level of a canal with locks is of such importance that it is necessary to make further and extensive investigations, chiefly by boring, to determine at what section of the geological valley the bedrock offers the most advantageous location. The borings thus far made disclose the maximum depth of bedrock to be somewhat greater than is desirable. A large field force began this investigation in the early part of July, and has continued it to the present time. It is still at work, and its operations will be continued until the data for this entire vicinity are complete. This field force is also making other surveys bearing upon the location of the canal a few miles southerly of Bohio.

The floods of the Chagres River are at times so sudden and of such magnitude that from the inception of the work of the Old Panama Canal Co. to the close of the investigations of the former Isthmian Canal Commission, it has been considered of the utmost importance to control them effectually, whether the sea-level canal or a canal with locks be constructed. In the former case, it would be highly objectionable to receive the flood waters of the river into the canal, as it would be difficult to prevent damage by the currents induced on the one hand, and by the silt, sand and gravel brought in on the other. Whatever measures might be adopted to control either of these sources of difficulty serious questions would probably result from either one or the other cause. In the case of a canal with locks being built, the method of controlling the floods proposed by the former Isthmian Canal Commission would be both simple and effective, but they would require some modification and adjustment if the summit level were as much as 20 or 25 ft. lower than contemplated by that body. Again, it would be feasible to create a reservoir on the upper Chagres by building a great dam either at Gamboa, as was at one time contemplated by the Old Panama Canal Co., or at a point farther up the river, as at Alhajuela, as planned by the New Panama Canal Co., as supplementary to whatever means of control might be adopted lower down the river. If a canal with locks should be built, this supplementary reservoir might ultimately be needed for additional water supply. Further, the possibility of diverting the waters of the upper Chagres River southward into the Pacific Ocean through a long tunnel piercing the Cordillera forming the continental divide in that vicinity, or possibly a shorter tunnel through the divide to the northerly side of the Chagres Valley toward the Caribbean, was seriously considered by both the Old and New Panama Canal companies. They even made surveys sufficiently extended to indicate that a tunnel about 10 miles long would be required for the diversion toward the Pacific.

All these earlier investigations were sufficient to disclose considerable data bearing upon the control of the waters of the upper Chagres; they were not far enough to settle conclusively the problems depending upon them and relating to the construction of a dam at Gamboa or to the construction of either of those two diversion tunnels.

CONTROL OF THE CHAGRES ABOVE GAMBOA.

One of the largest field parties first organized by the Commission was fully equipped to undertake and carry to completion all the surveys and investigations which would be needed for the solution of all questions as to the control of the waters of the Chagres River above Gamboa by the construction of a dam at that point, or at some point farther up the river, or by the construction of either of the diversion tunnels to which reference has just been made. The investigations of this party involved not only reconnaissance or exploration surveys throughout the entire valley of the Chagres River for a distance of about 15 miles above Gamboa, but also the use of complete boring outfits for the purpose of determining subsurface material at the proposed dam sites and tunnel locations. This party began its work in the early part of July and has prosecuted it continually to the present time and is still actively engaged in it. A large amount of conclusive information as to the topography of the rough, wooded country in this part of the Chagres watershed and of the Cordillera and as to the subsurface material down to bedrock at the site of the proposed dam at Gamboa and in its immediate vicinity has been obtained.

It has been shown by the surveys of the Commission that a portion if not all of the waters of the upper Chagres River may be diverted toward the Pacific Ocean, and thus taken entirely out of the canal prism, by a dam at Gamboa and a tunnel through the Cordillera not more than 7 miles long, or toward the Caribbean by a tunnel not more than about 4 miles long. A diversion in the latter direction is much less desirable than in the former, for the reason that such a diversion would lead the waters of the Chagres River to the canal near Gatun, about 5 miles from Colon, and make it necessary to care for them throughout that distance probably by an independent diversion canal. Obviously a diversion toward the Pacific is wholly free from any such objection. While it is probable that the work of this field party will have to be continued for a few months longer, the data which it has already secured are sufficient to determine some of the more important features of the problems upon which they bear.

GENERAL PURPOSES OF ORGANIZATION.

The organization of the department of engineering and construction has been made with two distinct purposes in view. The first of these purposes covered the entire field work, including surveys and investigations necessary for the solution of all problems preliminary to the development of plans for the entire project of a ship canal between the two oceans and the design and construction of water-works and sewer systems for the cities of Panama and Colon. The second purpose was the formation of the preliminary organization in such a manner as to merge efficiently into the permanent organization ultimately required for the actual construction of all classes of work embraced in the entire engineering construction within the limits of the Canal Zone.

This entire work has been vigorously pressed, first under the immediate direction of the managing representative of the Commission from the earliest moment at which it was possible to organize the various field parties and afterwards under the immediate direction of the chief engineer subsequent to his appointment and arrival on the Isthmus. This preliminary work is nearly completed, so that the studies for the features of the general project can soon be undertaken.

It is the purpose of the Commission to install and put at work at the earliest practicable moment a considerable number of large steam shovels, which have been purchased in the United States, in order to ascertain by actual trial certain important information regarding practicable rates of progress and of cost of work under the conditions existing along the canal line. Two of these shovels have already reached the Isthmus and will soon be at work. A similar line of experimental or investigation work upon a full scale of construction operations is to be undertaken in connection with the harbor excavations at Cristobal. The Commission regards these full-scale working operations of the highest value in order to determine reasonable requirements for rates of progress and to secure reliable information by actual trial as to reasonable unit costs of subsequent construction.

It has been found feasible to bring into usable condition much more of the machinery and plant turned over by the French company than was at first anticipated. It is the purpose of the Commission to make available in all future construction work as much of this machinery and material as can be advantageously used, and much progress has already been made in this direction, including the re-establishment of a machine shop of considerable capacity at Gorgona, where much heavy construction and repair work has already been done and is being done. The feasibility of excavating the Culebra Cut by the hydraulic method used in much mining work has been considered by the Commission. A thorough study

of th method of excavating was made on the Isthmus by Mr. A. Bingham, of San Francisco, who has extended expe ace in this special field of mining work. Mr. Bingham report on this matter has been made and is on file the office of the Commission.

WA R-WORKS AND SEWER SYSTEM FOR PANAMA AND COLON.

A engineering force for the special purpose of designing d constructing water-works and sewer systems for the ties of Panama and Colon was organized in the mon of June, 1904, and sailed from the city of New York soon thereafter. This force was so organized as to carr on its work under suitable supervision concurrent in both of these cities.

Pr r to the arrival of this field party the chief engineer had taken under consideration the project of supplying water to both cities in conference with Governor Davis, with the result that tentative selection was made for the water supply of Panama at the headwaters of the Rio Grande, about 10 miles from the city, near the southerly extremity of the great Culebra Cut, where the Old Panama Canal Co. had a reservoir formed by building a masonry dam across the river, a small stream at that place. Subsequent surveys confirmed the wisdom of this tentative selection, and the Rio Grande Reservoir, with an increased height of dam, was finally adopted for the water supply of Panama. The additions to the existing dam will raise the elevation of the water surface in this reservoir to 212 ft. above mean high tide. A 16-in. cast-iron pipe will form the conduit for conveying the water from the Rio Grande Reservoir to a distributing reservoir now in process of construction on the summit of a small hill at Ancon, where the surface of the water in it will be 137 ft. above tide. This reservoir has a capacity of 1,000,000 gallons and is constructed with two compartments, so that either may be used while the other is being cleaned or repaired.

This plan affords a gravity supply, the distributing reservoir being high enough to supply all parts of the city of Panama proper by its own head.

The work of construction of the entire system is being rapidly pressed toward completion, and it is believed that the first public water ever supplied to the city of Panama will be made available to the people of that city in the early part of 1905. This water supply system has been designed on the basis of supplying 60 gallons per head per day for a population of 30,000 people, although it is confidently believed that the source of supply is abundant for a much larger daily draft.

The details of connection at the distributing reservoir at Ancon are of such a character that in case of exigency water may be conveyed from the 16-in. conduit directly into the distribution system of the city without passing through the reservoir. The distribution system connecting the distributing reservoir with the different parts of the city has been laid out so as to serve efficiently all the buildings of the entire city wherever it is desirable that house or other building connections should be made. At other points on the streets or other public places where portions of the population may not have sufficient means to make house connections, hydrants or other taps have been provided and located so that water may be readily obtained without other cost than the effort to draw from the taps. All the details of the distribution system will be adapted to the local needs to serve conveniently and efficiently the requirements peculiar to a tropical climate. As the city grows in population and in area covered by buildings the adopted system may readily be extended to meet the needs of the increased population.

Before proceeding with the construction of the water supply system a considerable number of samples of water from the Rio Grande Reservoir were submitted for both bacteriological and chemical analysis to Messrs. Hazen and Whipple, of New York City, before even the banks and bed of the reservoir had been cleaned of vegetation. Those analyses showed the character of the water to be satisfactory, and it will be found improved in quality by the thorough cleaning of the entire reservoir site of all vegetable matter. If, however, at any time in the future it should prove desirable to filter the water, the vicinity of the distributing reservoir is such as to afford a suitable location for the requisite filters.

This system of water supply for the city of Panama is being designed and constructed in accordance with the best water-works practice at the present time, so as to secure not only excellence of work and materials, but also a quality of water to which no exceptions can be taken.

The city of Panama has no sewer or drainage system. It was necessary, therefore, to design and construct an entirely new system of sewers for every portion of the city.

A combined system has been adopted, but not with the intention of receiving the entire rainfall. It has been assumed that the greatest discharge of sewage will be on the basis of 60 gallons per head of population per day, and the system has been designed to offer accommodation in addition thereto for 1 in. of rainfall per hour.

The length of the entire system of sewers and the outfalls, as at present designed, has a total of over 92,000 ft., i. e., nearly 18 miles. Provision is made for 200 manholes, 150 catchbasins and 10 automatic flushtanks. The total estimated cost of this sewer system is $256,450.

The city of Colon is built upon a flat, sandy island, no part of which is more than about 4 ft. above mean sea level. Indeed, considerable portions of it are covered with water at high tides caused by high winds from the north. A portion of the city occupied by officials and other employees of the Panama Railroad and by the foreign consuls is already supplied with water brought by the railroad company through a small iron pipe from a small reservoir containing water of somewhat indifferent quality near Mount Hope, about 2½ miles from the city. The remainder of the population supplies itself from rainwater falling upon the corrugated iron roofs of buildings and collected in iron tanks. There is no suitable and sufficient surface water supply readily available in the near vicinity of Colon. Investigations, however, are being made to discover as soon as possible either some more remote surface source or a subsurface supply from the deep sands and gravels south of the city along the district traversed by the canal line or in some other quarter. The search for wholesome public water supply for Colon has not proved to be so easily successful as that for the city of Panama. The Commission's investigations, however, are being actively prosecuted in all directions, and it is expected that by the early part of the coming year at farthest the problem of palatable water supply for Colon will be solved, although at the present time a report of progress only may be made.

WORK AT THE CULEBRA CUT.

When the United States Government took possession of the canal property on the Isthmus the New Panama Canal Co. had about 700 men engaged in the work of excavation at the deepest part of the great Culebra Cut, in connection with the occasional use of one or two bucket excavators of the type in use by the Old Panama Canal Co. during its period of activity between the years 1881 and 1889.

Immediately upon the arrival of the chief engineer at Panama, the working force at Culebra was entirely reorganized so as to bring it into a more efficient condition, the plant was overhauled, repaired and made more effective, and at the same time a system of field accounts and reports was devised and put into use so that a complete record of progress and cost of all classes of work being prosecuted might daily be maintained. Three other excavators in the vicinity of the Culebra Cut were repaired and brought into effective working condition. This reorganized force has been maintained and improved so that it might be conserved as a nucleus from which the ultimate complete working force of the entire canal construction can be developed.

Up to the month of October this force became smaller than when it was originally tured over by the French company, but owing to the gradual increase of working plant, chiefly by the purchase of large steam shovels from the United States, an additional force will soon be necessitated and engaged. It is expected that this increase of labor force with the increase of plant will be constantly maintained. The revival of the work of construction of the canal and the maintenance of this organized force is proving to be, as was intended, an inviting center toward which efficient laborers are moving.

SANITATION.

Appreciating the importance of taking every possible precaution for the protection of the health of the employees of the Commission on the Isthmus, as well as of the inhabitants of the Canal Zone, the Commission lost no time in organizing a health department. The Commission on its first visit to the Isthmus was accompanied by Dr. W. C. Gorgas, Colonel, U. S. Army; by Dr. John W. Ross, U. S. Navy; by Dr. L. A. La Garde, Major, U. S. Army, and an engineer officer of the Army, Capt. (now Maj.) C. E. Gillette. The medical officers above named are of the staff which operated with such signal success during the American occupation of Cuba, and all have found places on the staff of the medical department of the Commission as subsequently organized.

The final organization of the health department was perfected in August. The affairs of the health department are administered by a board of health, composed of four members, as follows: The chief sanitary officer, the director of hospitals, the chief quarantine officer and the chief sanitary inspector of the Canal Zone.

There were found upon the Isthmus, as a part of the canal properties, an extensive hospital established at Ancon, immediately adjacent to Panama, and a hospital, or rather several neglected hospital buildings, at Colon. Both of these hospitals were without adequate medical staffs, and, in lieu of trained nurses, the Sisters of the Order of St. Vincent de Paul attended upon the sick. These buildings are being repaired and adapted to modern hospital requirements as rapidly as possible.

The capacity of Ancon hospital is about 500 beds, but in case of an emergency sufficient ward space is available to place upward of 700 beds.

The work of repairing and remodeling the hospital building at Colon is already well advanced, and some additional structures are being erected, it being the purpose of the Commission to bring the Colon hospital to a capacity of about 300 beds.

In addition to the hospitals at both ends of the canal, emergency hospitals, each with a capacity of four to eight beds, are to be established as may from time to time be required along the line of the canal at points where a considerable number of canal laborers or inhabitants of the Zone may be resident. Three such emergency hospitals have already been authorized, being located at Culebra, at Gorgona and at Bohio. The physician at each of these emergency hospitals will also be in charge of a dispensary. Two additional dispensaries not combined with emergency hospitals have been authorized.

All employees of the Commission stationed upon the Isthmus are entitled to free medical treatment and medicines. It is proposed to care for the sick in the hospitals in all cases of serious illness. The patients not only receive better care in the hospitals than they could elsewhere, but the special precautions taken at the hospitals to prevent the spread of disease by insects safeguard the public health.

It being a special duty of the board of health to prevent the spread of contagious and infectious diseases and to stamp out, if possible, the malarial types of fever, unusual efforts are being made to destroy the mosquitoes which spread yellow fever, malarial fevers and other diseases. This work has been intrusted in the Canal Zone to a well organized staff of sanitary inspectors. Water containers are being covered, ponds and pools of standing water are being drained or covered with oil to prevent the breeding of mosquitoes, and special care is taken to dispose properly of all filth accumulations and waste of all kinds.

The board of health of the Commission is charged with the duty of prompt action in all such cases, it being the policy of the Commission to have all persons afflicted with yellow fever or similar diseases cared for in such a way as to reduce the danger of a spread of the disease to a minimum.

After a careful investigation of the requirements of the health department, it was, at the time of its organization, estimated that the expenditure for repairs to buildings, the erection of new buildings, proper equipment thereof, medicines and supplies, and compensation of the staff of employes would aggregate, in the ten months of service succeeding August, 1904, about $1,100,000. The expenditures during the next year may possibly exceed $800,000. It cannot now be forseen whether the expenditures of this department will continue throughout the entire period of the canal construction as the above figures indicate, or whether the experience of the first few years will justify a decrease, or will demand additional allowances. It is confidently hoped by the Commission that the diseases prevalent in the past upon the Isthmus, and which have given it its bad reputation for unhealthfulness, will be brought under control and that epidemics of disease will be entirely prevented.

As soon as the Commission has decided upon the details of the great canal project, steps will be taken to bring an ample supply of water of good quality to every settlement along the line of the canal.

SUPPLIES.

As soon as the Commission was appointed, and before the organization of its several departments was practicable, urgent demands arose for supplies of various kinds. Under this condition it was necessary that some considerable purchases should be made in open market, or by the invitation of propositions from well-known dealers in various parts of the country. Great care was taken in the issue of these invitations to avoid partiality to individuals or to localities, and in all cases the freest practicable competition was sought. Although this is a method of purchase recognized and approved by the Government as conducive to its interest in cases of emergency, and although the instances in which it was used by the Commission were, in its opinion, those for which it was intended by the Government, yet the Commission at all times had the intention of resorting to the method of public advertisement as soon as practicable and to the greatest extent possible. Therefore, at its meeting of Aug. 18, while the Commission was on the Isthmus and engaged in the organization of its various departments, it was resolved:

That hereafter, so far as practicable, all purchases of machinery, material and supplies shall be made after due advertisement and competition.

This policy has since controlled the Commission in all its purchases, except those of an extremely small amount or those similar to anæsthetics or disinfectants urgently needed at the hospitals. Even those will be discontinued as soon as the experience of the heads of departments enables them to more fully foresee all of their needs.

EXPENDITURES AND ESTIMATES.

The expenditures of the Commission to Sept. 30, 1904, on the canal work, on engineering studies, on water-works and sewerage systems for Panama and Colon, and for the government of the Canal Zone, including about $15,000 expended prior to the appointment of this Commission out of the appropriation of $10,000,000, may be briefly summarized as follows:

Salaries of Commission	$49,316.14
Salaries of all other officers and employees, Washington office	24,247.63
Traveling expenses, Commission and employees	13,836.54

Salaries:		
Health department	$36,776.52	
Police department	14,477.54	
Other Zone employees	6,542.52	
Salaries and labor rolls:		
Engineering department	174,962.46	
Material and supplies department, disbursing office and land administration	54,411.29	
		287,170.33
Supplies shipped to Isthmus		112,575.70
Miscellaneous expenses:		
At Washington, rent of offices, furniture, fixtures, stationery, office supplies, cable and telegraph services, books, blanks, printing, etc.	15,761.31	
On the Isthmus, supplies, etc., for all departments	31,582.51	
		47,343.82
Total		$534,490.16

It is thought that the expenditures from the appropriation of $10,000,000 for a canal connecting the Atlantic with the Pacific Ocean to the end of the current fiscal year, June 30, 1905, including expenditures made prior to the appointment of this Commission, may reach an aggregate of $5,000,000, depending upon the time that may be required to get the construction work well under way after the Commission has adopted the final plans of the canal. In the following fiscal year the increasing necessities of the work may require an expenditure of $15,000,000 or even more.

The supplemented report of Gen. Davis contains among other matters the following of special interest relating to the labor problem on the Isthmus:

The labor question is going to present many difficulties to the Commission, and a solution has not yet been reached. The total number of employees on the canal work on the Isthmus on Sept. 30, was as follows:

	Salaried employees paid in gold.	Laborers and others of similar classes paid in silver.
Engineering department	218	1,948
Material and supplies department	28	265
Accounts and disbursements	7	....
Sanitary department	97	453
Police department	87	....
Other departments of the Zone government	34	9

Since September 30 the numbers have been increased about 25%, which would make at the present time a total force of employees of about 3,500.

A good deal of private work is now in progress on the Isthmus, such as house construction, and all the mechanical and other labor that is available is now engaged. The engineering department needs 1,000 men at the present time, and the sanitary department about 300 more; but they are not obtainable. On account of the dearth of labor, and competition between the railroad, the government, and private employers, the prices are advancing. The general character of those arriving and seeking employment is not a good one for economical laboring work. Nearly all of those now employed are negroes and about one-half of them are natives of the West Indies Islands, or foreigners, principally Jamaicans.

The labor is not efficient. In the opinion of those who have been employing colored and white labor in the United States, the wages paid now to the ordinary laborer, amounting to $1.50 silver a day, are really higher than the rates prevailing in the United States of $1.50 to $2 gold. The total number of laborers employed on the canal at the time of the greatest activity of the French company is said to have been about 15,000.

It is hoped by the chief engineer to accomplish a great deal of the work of excavating the canal by mechanical means, so the number of laborers will be less than otherwise would be the case; but, nevertheless, a very large number of persons of the ordinary working class must be engaged for service upon the Isthmus before the canal work begins. It seems as if it will be necessary to obtain them under some arrangement of a contract obligation. To bring men from the United States at a great expense, and then have them immediately take their departure because they can obtain higher wages either on the Isthmus or by going to the old mines or to South American States, is very poor business. It will be impossible to make any rapid progress, even in the limited work that is now going on, unless a larger force of laborers can be obtained.

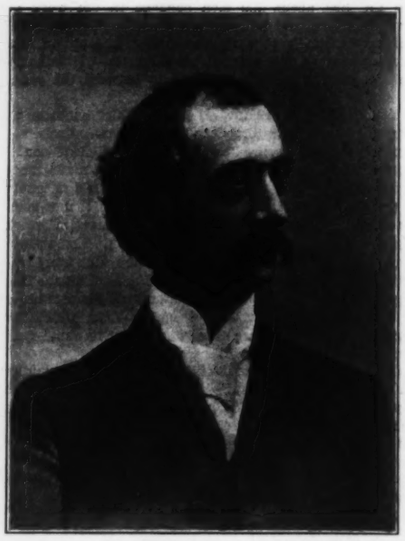
It is useless to discuss the question of utilizing the white race for heavy out-door work with pick and shovel, in the mud and rain, on the Isthmus; no one has ever succeeded in obtaining such a force of the Caucasian race. Negroes from the Southern States would of course be available, but the expediency of bringing them here is doubted, for they will be immediately placed in competition with their own race in the vast numbers that are already here, and I should not expect that harmonious relations between them would result; especially if one was paid wages current in the United States, and another black man on the Isthmus was paid the wages current on the Isthmus, there would be constant friction. It is important that measures be taken to solve this problem as soon as possible.

ERNEST MARCEAU, PRESIDENT OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

The election of Mr. Ernest Marceau to the presidency of the Canadian Society of Civil Engineers is a good index of the harmonious co-operation of the French and English races which distinguishes the eastern provinces of the Dominion of Canada. The retiring president of the society, Lieutenant-Colonel William P. Anderson, of whom we presented a portrait and biographical sketch a year ago, represents the English element in Canada's public service. Mr. Marceau in similar manner represents the French element. Like Lieut.-Col. Anderson, he has been in public service throughout his professional career. It is a curious coincidence, moreover, that both Mr. Marceau and Lieut.-Col. Anderson are identified with navigation service, though in different branches, Lieut.-Col. Anderson being at the head of the Dominion Department of Marine and Fisheries, while Mr. Marceau is in charge of the Canals of the Province of Quebec.

Mr. Ernest Marceau is descended from an old French family of the City of Poitiers, one of his forefathers having established in Canada at the beginning of the eighteenth century.

He was born in December, 1852, at Danville, in the Eastern Townships of the Province of Quebec. At the age of thirteen, after having gone through the usual commercial course, he took a full course in classics and science at the Montreal College, coming out in 1874, and for the next three years studied engineering at the "Ecole Polytechnique de Montréal," from which he graduated with honors in 1877.



Ernest Marceau

In August of that year he entered the service of the Dominion Government, his first appointment being as Assistant Resident Engineer on the Grenville Canal, then in course of enlargement. Three years later he was appointed Assistant to the Superintending Engineer of the Ottawa River Canals, holding the position until May, 1893, when he was given charge of the Canals of the Province of Quebec as Superintending Engineer, with headquarters in Montreal.

His duties in this position include construction and maintenance work, as well as collection of revenue and general management of the following works: The Lachine, Soulanges and Beauharnois Canals, on the St. Lawrence River route; the Sainte Anne, Carillon and Grenville Canals, on the Ottawa River route; and the Saint Ours and Chambly Canals, on the Richelieu River route.

Among the works performed under his direction and immediate supervision may be mentioned the rebuilding of a considerable section of the Carillon Dam, a cribwork structure, 1,800 ft. in length, thrown across the Ottawa River at the head of the Carillon Canal, as well as the strengthening and staunching of the rest of the dam. The operations here, which covered three summer and two winter seasons, are described in a paper read before the Canadian Society of Civil Engineers, for which he was awarded the Gzowski Medal of the Society. Other works are: The building of four large swing bridges over the Lachine Canal, at Montreal; the lengthening of two locks at the Montreal entrance to the same canal; the construction of a power house, electric light lines and power lines for the operation of lock gates and bridges on the Lachine Canal; the widening and deepening of two sections of the Grenville Canal; the building of sewers in the town of St. Johns, on the Chambly Canal, and in the town of Valleyfield, on the Beauharnois Canal.

In his younger days Mr. Marceau gave some of his leisure hours to literature. He has always taken an active interest in educational matters, and is at the present time Principal of the "Ecole Polytechnique de Montréal," and member of the Faculty of Arts and of the Board of Administrators of Laval University. He is also a member of the "Société des Ingénieurs Civils de France."

He has been connected with the Canadian Society of Civil Engineers since its foundation in 1887, and has served as member of Council from 1897 to 1901, and as Vice-President from 1901 to the present time.

THE SETTING OR HYDRATION OF PORTLAND CEMENT.*

By Clifford Richardson.†

I have previously shown‡ that the constitution of Portland cement clinker can be satisfactorily explained if it is considered as a heterogeneous solid solution; that is to say, if it is regarded as consisting of two solid solutions of different degrees of basicity which have been crystallized from a more or less mobile magma on cooling; the one of tri-calcic aluminate in tri-calcic silicate, and the other di-calcic aluminate in di-calcic silicate, the character of the cement depending upon the relative proportion of the two materials and upon the degree of concentration of the solutions of the aluminates in the silicates.

On the addition of water to a stable system made up of the solid solutions which composed Portland cement a new component is introduced which immediately results in a lack of equilibrium, which is only brought about again by the liberation of free lime. This free lime the moment that it is liberated is in solution in the water, but owing to the rapidity with which it is liberated from the aluminate, the water soon becomes supersaturated with calcic hydrate, and the latter crystallizes out in a network of crystals which binds the particles of undecomposed Portland cement together. From the characteristics of the silicates and aluminates it is evident that the latter are acted upon much more rapidly than the silicates, and it is to the crystallization of the lime from the aluminates that the first or initial set must be attributed. Subsequent hardening is due to the slower liberation of lime from the silicates. If the lime is liberated more rapidly than it is possible for it to crystallize out from the water, expansion ensues and the cement is not volume constant.

The set of Portland cement is almost entirely due to the decomposition of the alit alone. Examination of a thin section of a neat Portland cement mortar will show that it contains large quantities of unattacked celit and a certain amount of unattacked alit. If the fractured ends of a neat Portland cement briquette are held together by means of a rubber band and then immersed some time in water, the pieces of the briquette will be found to have become cemented together owing to the setting of the portions of unacted cement on the surfaces of the fracture.

The strength of the Portland cement after setting is due entirely to the crystallization of calcium hydrate under certain favorable conditions, and not at all to the hydration of the silicates or the aluminates, since in this act of hydration nothing can take place which would tend to bind these silicates and aluminates together. Celit is certainly decomposed to but a slight degree in the process of setting. From this we may infer that the strongest cement is the one which contains the smallest amount of celit, and such a conclusion is entirely justified by experience. The more high in lime a cement is the greater its strength is known to be if it is thoroughly burned.

Since the hardening of Portland cement is due to the liberation of free lime and its subsequent separation from the supersaturated solution in a crystalline form, it might at once be inferred that any basic compound of lime

*A paper read before the Association of American Portland Cement Manufacturers, New York City, Dec. 14.
†New York Testing Laboratory, Long Island City, N. Y.
‡Engineering News, Aug. 11, 1904.

from which the latter is liberated by water, would have very basic properties, and that silica and alumina were not the only acid radicals with which lime must be combined to produce such a result. It is well known that a Portland cement can be made in which all the alumina is replaced by iron. As the compounds of iron and lime are decomposed much more slowly by water than those of alumina and lime, this cement would be supposed to be very slow setting. Such cements have been made by a number of persons, and there is an exhibit here of one which sets in two hours without heating, and at 28 days had a tensile strength of 570 lbs. In the same way, it may be assumed, it might prove possible to substitute manganese for iron. This has been done, and a hydraulic cement obtained which is, of course, of no industrial importance, but which sets very well, and a small sample of which is exhibited.

If iron or manganese can be substituted for alumina, the question arises whether silica cannot be substituted by the elements of the same group, such as titanium, tin and lead. Clinkers have been made in which this has been done, and the ground clinker in each case has been found to set rapidly, although the resulting test pieces were not volume constant, the temperature obtainable in our furnace being evidently insufficient to bring about a thorough combination between these elements and lime. Cements have also been made in which phosphoric acid has been substituted for silica.

If various aluminates can be substituted for acid radicals, it would seem possible that other alkaline earths might be substituted for lime. Clinkers have been made in which strontium and barium are the bases. They must be burned at a very much higher temperature than similar clinkers containing lime. In powder these possess strong hydraulic properties, and are volume constant in water for a few days, but, owing to the greater solubility of strontium and barium hydrate in water than of lime, the material after setting is much more readily attacked by water than in the case of lime cement, strontium hydrate being about twice as soluble as calcium hydrate, and barium hydrate about eight times as soluble.

The preceding results are of great scientific interest in explaining the hydraulicity of basic materials in general and in making more intelligent our understanding of the causes of the setting of Portland cement. Industrially they are only of interest in so far as they point to the fact that it might be possible to make a Portland cement at a comparatively low temperature from a silicious iron ore and a pure limestone. As soon as a supply of a suitable iron ore for this purpose can be obtained, an attempt will be made to manufacture a cement of this description.

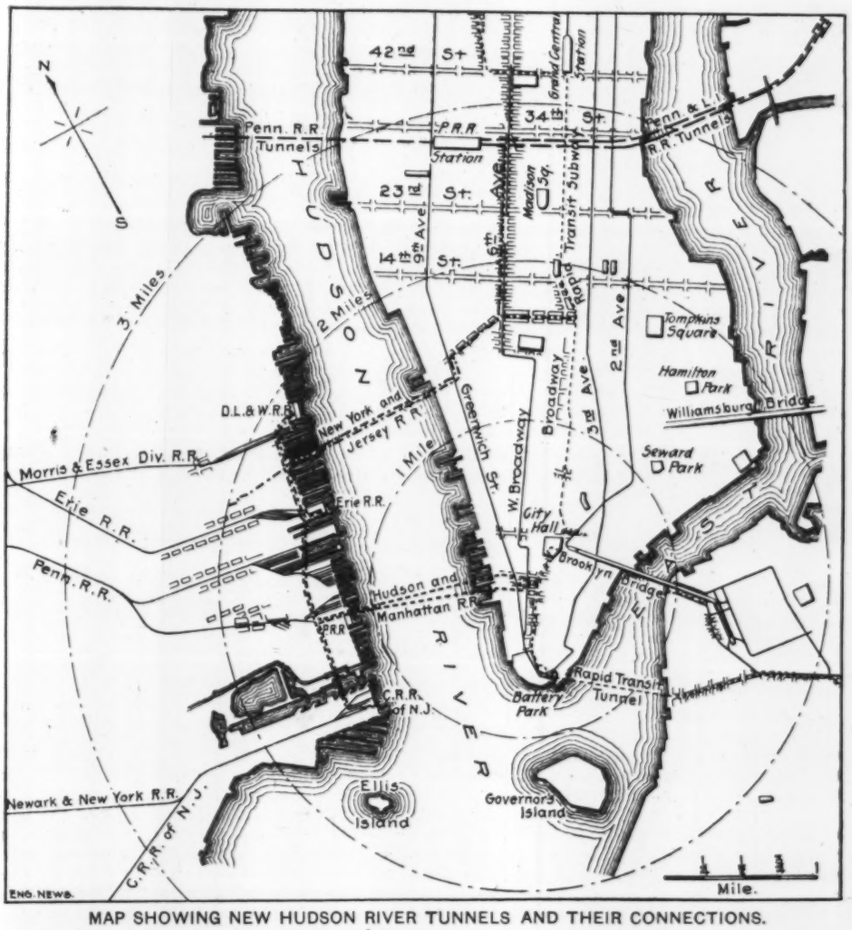
The materials of different degrees of fineness which can be obtained by elutriating the raw mixture usually used in the Lehigh Valley have all been described. If the finest material is burned at a temperature which ordinarily results only in the sintering of the material before elutriation it is very readily fused, as shown by the specimens exhibited. This illustration is of great importance in pointing out the fact brought to your attention six months ago that the fineness of grinding will be accompanied by a reduction in the expenditure of fuel and in the time during which it is necessary to expose the raw mixture to a definite temperature.

There has been outlined in the preceding remarks the directions in which the speaker's investigations on the constitution of Portland cement have been extended during the last six months. It is impossible, of course, in the present place to go into the matter, especially as regards the role that iron plays in the formation of a cement, in greater detail, but the hope is expressed that those chemists and superintendents who are present and who can conveniently come to the laboratory where the work is going on will do so, and discuss the matter in greater detail. It is already evident that the microscopic examination of thin sections of industrial clinker may in many cases explain the peculiar characteristics of the cements obtained from them. It will not do so in all cases, but the continued examination of large numbers of clinkers will enable us to understand the structure of those clinkers which produce unsatisfactory cement, so that we may eventually be able to draw much more extended conclusions than we are able to at present.

THE NEW HUDSON RIVER TUNNELS.

The successful prosecution of the old Hudson River Tunnel work by its new owners has led to the development of an elaborate system of underground tunnel lines connecting the railways entering Jersey City with the subway and elevated railway lines of Manhattan Island. As will be remembered, the property of the old Hudson River tunnel company was purchased about two years ago by capitalists who formed the New York & Jersey R. R. Co. to continue the under-river work and to develop a suitable system of underground terminals and connections. Later, the same capitalists supplemented their original plans by organizing a second company known as the Hudson & Manhattan R. R. Co. to build a second twin-tube tunnel under the river and to develop its necessary shore terminals. Together, the two plans provide for four single track tunnels under the Hudson River, for a system of shore tunnels connecting the various railway terminals in Jersey City, and for a similar system of shore tunnels on anhattan Island connecting with the new underground Rapid Transit Railway.

The accompanying map shows the locations of these new Hudson River tunnels and their connections. So far the only actual construction work has been done by the New York & Jersey R. R. Co. This company has continued the partly continued north tube of the old Hudson River Tunnel to completion, and is now constructing the south tube as described in our issue of Nov. 10, 1904. The Hudson & Manhattan R. R. Co. has completed plans for its tunnels and is about ready to begin construction. Until recently the work



MAP SHOWING NEW HUDSON RIVER TUNNELS AND THEIR CONNECTIONS.

of the two companies has been kept separate, but plans have now been completed for carrying on the work of both companies by a single organization.

On Jan. 9, the Hudson Companies was incorporated in New York State to take over the work for the New York & Jersey and the Hudson & Manhattan railway companies. This company completed its organization on Jan. 17, by electing permament directors and the following officers: President, Walter G. Oakman; Secretary, Kenyon B. Conger; Treasurer, Henry A. Murray; Chief Engineer, Charles M. Jacobs, M. Inst. C. E.; Deputy Chief Engineer, J. Vipond Davies, M. Am. Soc. C. E.; and Consulting Engineer, William Barclay Parsons, M. Am. Soc. C. E. As organized, the Hudson Companies is simply a construction company to take over and complete the construction work previously laid out by the railway companies. These latter companies still keep their original organization with Mr. W. G. McAdoo as President.

The tunnels which are to be built will, with the exception of the branch up Sixth Ave., be deep tunnels with circular cast-iron lining and an interior diameter of 15 ft. 2 ins. They will operate electric trains substantially the same as are operated on the Rapid Transit Railway. The line up Sixth Ave. will be subway construction similar to the Rapid Transit Railway. It is stated that traffic contracts have been made with the Pennsylvania, the Erie and the Central R. R. of New Jersey and that it is expected to complete a similar contract with the Delaware, Lackawanna & Western R. R.

THE RECONSTRUCTION OF THE POINT BRIDGE, PITTSBURG, PA.

By Willis Whited.*

The Point Bridge was built in 1876-7 by a private corporation, known as the Point Bridge Co. In 1896 the city of Pittsburg bought the entire capital stock of this company and thus became the owner of the bridge. The span being very long for those days, 800 ft., it was considered necessary, in order to make the bridge practicable, to reduce the weight of the floor system to the lowest possible limit. This is illustrated quite forcibly by the accompanying view, Fig. 1, of a floor beam which is typical of the whole structure below the chains. The bridge was never very well cared for, having been painted only once or twice since its erection. It was used for many years by horse cars, and during the winter season the roadway was frequently sprinkled with salt, besides which the ordinary drainage from a roadway corrodes ironwork very rapidly. The result was that many parts of the floor system, originally designed very light, had been weakened from 20% to 40% by corrosion. In addition to this, the horse cars had been replaced by much heavier electric cars, and the general traffic had increased very greatly.

The weakness of the bridge was well known,

*Assistant Engineer, Department of Public Works, Pittsburg, Pa.

and, as soon as it was acquired by the city, Mr. E. M. Bigelow, M. Am. Soc. C. E., Director, Department of Public Works, employed Mr. John Brunner, M. Am. Soc. C. E., to make a thorough examination of the structure, and prepare plans for repairing it. These plans were completed in January, 1897, but it was impossible to persuade the city fathers to loosen the public purse strings sufficiently to allow the work to be done. In 1901 the author, under the direction of Mr. Brunner, made a revision of the plans.

On Dec. 24, 1903, the watchman employed on the bridge notified the author that a certain part of the floor sagged quite perceptibly whenever a car passed. An examination was immediately made, and it was found that three floorbeams had broken; one of them is shown by Fig. 1. As the city had no funds available for such an emergency, arrangements were made with the Pittsburg Railways Co. to make temporary repairs, which consisted of suspending a 24-in. I-beam under each broken floorbeam by means of four long 1½-in. bolts at each end. The material was shipped to the site that same day, and heavy traffic was diverted to other routes. This sudden closing of an important thoroughfare on Christmas day aroused so much public comment that there was no difficulty in obtaining an ample sum to carry out the repairs so long desired, when the annual appropriations were made in the following February. The contract was awarded to the Pittsburg Construction Co. at $92,000, and by them the work was prosecuted with energy and skill from the time traffic was closed, May 31, 1904, until it was re-established Dec. 8, 1904.

FIG. 1. BROKEN FLOOR-BEAM FROM CENTER SPAN OF OLD POINT BRIDGE, PITTSBURG.

The bridge, as shown by Fig. 2, consists of a main suspension span 800 ft. long, and two independent deck truss side spans of 144 ft. each. The roadway was 20 ft. and the two sidewalks were each 7 ft. in width; the joists and flooring were all of wood, 3-in. white oak being used for the flooring. In the general design of the side spans, about the only peculiar feature is the section of the posts, which was that shown in Fig. 3; the flange sections of which, now long obsolete, were first used, if I am not mistaken, by the Baltimore Bridge Co.

The main span is peculiar. The chain consists entirely of 8-in. eye-bars. The upper stiffening trusses consist of straight chords built up of two channels and a cover plate, connecting to the chain at the center of the span and at the tops of the towers, and I-beam posts, connecting to the chain at each panel point, with rods for diagonals, all pin connected. There is also a lower stiffening truss on each side, with an expansion joint at every fifth floorbeam. These are 8 ft. deep and extend from the top of the railing to the bottom of the floorbeams. They consist of T-section chords built up of 3 × 3 × 5-16-in. angles and 8 × ⅜-in. webs; of verticals built of four 2 × 2 × ¼-in. angles forming a star section, and of diagonals of 4 × ⅜-in. bars, all connections being riveted. Each hanger consisted of two 1⅜-in. rods with upset ends.

The details of the floorbeams are plainly shown by Fig. 1. The flange angles were 3 × 3 × 7-16 ins.; the top flange plate 6½ × 7-16 ins., and the bottom one 9½ × ⅜ ins. The lattice bars, of which the webs were composed, were 4 × ⅜ ins., with two ¾-in. rivets in each end, for the end sections, and in the center section the bars were 3 × ⅜ ins., with one ⅞-in. rivet in each end. The flange angles were 33 ins. back to back. The exact original sections of the flanges were difficult to determine on account of the corrosion which had taken place.

The two lines of stringers were 24 ins. deep, the flanges consisting of two 3 × 3 × ⅜-in. angles, and the double latticed webs of 2½ × 7-16-in. bars; the end rivets of adjacent panels of lacing were about 8 ins. c. to c.

The bottom lateral bracing consists principally of two 2½-in. wire storm cables on each side, secured to the ends of the main piers at the level of the bottom of the floorbeams and stretched in the form of a horizontal parabola, whose vertex is as near as possible to the truss on the opposite side of the bridge at the center of the span, as shown in the sketch, Fig. 4. The wire cable was secured to each floorbeam with U-bolts. In addition to these, there were 1-in. lateral rods arranged in double panels passing through the end and center tie-plates of the floorbeams alternately, and held by nuts and beveled cast washers.

Each tower post is composed of four posts battered from bottom to top and strongly latticed together. On the top of each cluster of posts is a longitudinal box girder with four webs 5 ft. deep, well stiffened, and surmounting this is a cross box girder containing 10 webs 12 ins. deep. This box girder carries a nest of rollers supporting the saddle, which consists of twelve 2 × 16-in. plates set on edge and resting on a plate on the rollers. The columns rest on cast bases, which are tied together by 10 × ¾-in. plates resting on the masonry.

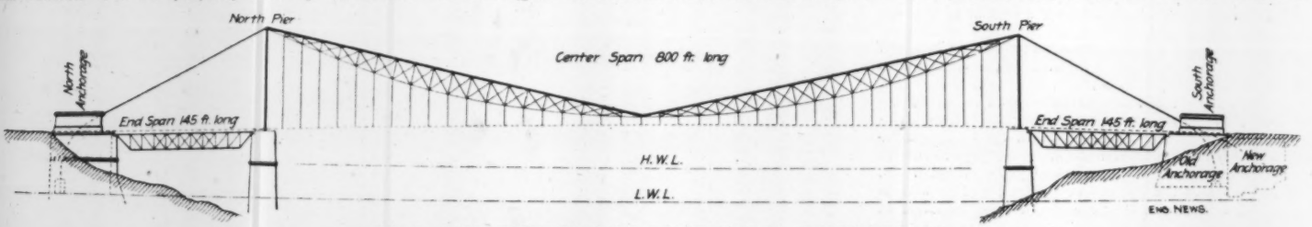


FIG. 2. SIDE ELEVATION OF POINT BRIDGE, PITTSBURG, PA.

Fig. 3. Section of Posts in Side Span Trusses.

Fig. 4. Diagram Showing Arrangement of Storm Cables.

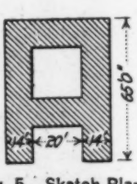


Fig. 5. Sketch Plan of Anchor Pier.

The back chains extend in a vertical curve down into heavy stone piers and terminate in heavy cast anchor plates built into the masonry. These piers are shown in the sketch Fig. 5, and extend down about 50 ft. below the roadway level. They were surmounted by stone pedestals 50 ft. long, 10 ft. wide and about 20 ft. high.

CONDITION OF THE OLD STRUCTURE.

The north anchorage showed no signs of weakness, but the south one moved some inches soon after the bridge was completed. This sliding was ascribed by some to a landslide on the hill in the rear, and by others to a test load which was applied shortly after the bridge was built. I am of the opinion that it was caused by the fact that the pier rested on clay. This clay, although hard, contains very little sand, and when wet its coefficient of friction is very small. As there was comparatively little earth in front of the masonry the heavy stress applied when the ground was saturated with water caused it to slide. The anchorage piers were very poorly built. The face stone, although none too good, was laid in heavy courses, but the backing contained much small stone. It was apparently laid dry, and when about 5 ft. high was grouted with mortar. This mortar was so thick that it seldom penetrated more than a foot or two into the mass, so the remainder was left dry. Another layer of similar thickness was then built up and treated in the same manner. The result was that those piers were little better than piles of dry stone, as shown by Fig. 6. No attempt was made to grout between the eye-bars nor even to fill the spaces between them where they entered the anchorage (Fig. 7); the result was that they were considerably pitted for 5 or 6 ft., but, beyond that, the paint was almost intact. The other parts of the chain had suffered no appreciable damage from rust.

The upper stiffening truss had suffered comparatively little except in some places, where the rivet spacing was too great for the thickness of the cover plates, and on the splice plates where the rivets were 2 or 3 ins. from the ends of the plate it had rusted under the plates and bulged them up.

The top cross struts between the towers had rusted between the lattice bars at their intersections so that some of the rivet heads had been forced off. The box girders at the tops of towers were considerably corroded inside, but no other serious damage was done to the upper parts of the towers. There were ornamental hollow cast bases around the bottoms of the columns, and the iron was corroded very badly under them, ⅛-in. or more being rusted away. The 10 × ¾-in. plates used for tying the bottoms of the columns together under the bases were rusted almost through.

The stringers were badly rusted, especially between the flange angles, but there were no signs of failure, except that some of the heads were broken off the end connection rivets. The floorbeams were in bad condition, Fig. 8. In a number of places the top flange plates were rusted entirely through, and in numerous places rust had formed under the top flange plates and bulged them up ⅛-in. or more between the rivets. There were two floorbeams at each expansion joint, one supported by the long hanger, and one riveted to the stiffening trusses with ten ½-in. rivets at each end. In two places rust had formed between the connection angles and forced them apart, breaking five of the rivets. The bottom flange angles were separated by the lattice bars, with

FIG. 6. VIEW SHOWING CONDITION OF MASONRY IN SOUTH ANCHOR PIER.

the flange plate below forming a receptacle for water, and the rust between them had bulged many of them ¼-in. or more, and some of the rivet heads had broken off. The frequent reversal of stress in the middle section of the floorbeams had loosened a large proportion of the rivets in the ends of the lattice bars. Eight of the floor beams had failed in one end section by the buckling of the lattice bars, and in two or three cases the flange angles had cracked.

Very little of the iron that was removed was crystallized to any extent, in fact, I could see no evidence that the iron was any worse in that respect than when it was first put in the bridge, notwithstanding 26 years of heavy traffic. The side spans were not badly deteriorated by rust, except some of the bottom struts, which although quite badly rusted were not in a dangerous condition, and the floorbeams. The stringers were of wood. The top flanges of some of the floorbeams were rusted away at least 30%. The bottom flanges also rusted badly, as the side spans are on a considerable grade, and the bottom flanges on the uphill side hold water. One of the counters broke in 1902 and was replaced by a new one.

It should be the invariable rule, whenever a wooden bridge floor is torn up for repairs, that all steelwork which is accessible only at that time should receive at least two coats of paint.

THE REPAIRS THAT WERE MADE.

Enough stone was removed from the pedestals on the north anchorage to expose about 20 ft. of the eye-bars to ascertain whether they were corroded to any serious extent, the intention being to reinforce them if it was found necessary. As they were found practically uninjured, they were thoroughly grouted with 2 to 1 Portland cement grout; the stone which had been removed was replaced with concrete backing, and the bars thoroughly protected with Portland cement mortar, up to where they emerge from the pedestals.

The south anchorage was reinforced by making an excavation 14 ft. wide, 63 ft. long, and about 60 ft. deep, in the rear of the old anchorage, on the line of each chain and filling it with concrete. In each was bedded near the rear end a pair of anchors, each built up of six 24-in. 100-lb. I-beams 9 ft. long, with ½-in. plates top and bottom, and connected by means of a 9-in. pin to five 8 × 2-in. steel eye-bars, 56 ft. long. To these were connected four 8 × 2½-in. bars 40 ft. long, and to these five 8 × 2-in. bars 48 ft. long, which were connected to the old chain by means of a toggle joint.

It was found impracticable to go to bed rock with the foundations. At the depth to which they were carried numerous large boulders were found. Those which were entirely in the holes were removed, but any which were only partly in the hole were left in place, the soil removed from between them and the spaces rammed with concrete. These boulders were thus made to act as dowels which tied the new anchorage to the surrounding soil, greatly increasing its resistance to sliding.

The original intention was to cut into the sides of the old piers to make room for the new bars, but owing to the faulty construction of the masonry, this was out of the question, and it was necessary to remove the old masonry down to the line of the new bars. This would reduce the weight of the old anchorage to a dangerous extent, so, as a precaution, three alternate 24-in. courses of stone were cut from the back of the old pier to a depth of about a foot and the whole excavation filled with concrete to within about 2 ft. of the new steelwork. As the recesses cut in the old masonry were about 20 ft. below the new steelwork, an excellent bond was formed between the new and the old masonry, which afforded abundant security against overturning when the upper masonry was removed.

The details of the toggles are shown by Figs. 9 and 10. The object of them, of course, is to transfer a portion of the stress from the old chain to the new one, and thence to the new anchorage.

The entire floor system was removed from the main span and replaced with new floorbeams 33 ins. deep, with 5-16-in. webs and 6 × 3½ × ⅝-in. flange angles. To the bottom of each floorbeam the old storm cables were secured by U-bolts made of 1 in. steel. There are four lines of 15-in., 42-lb. I-beam stringers, one under each street car rail, riveted to the webs of the floorbeams and also resting on shelf angles riveted to the same webs. Resting on the tops of the stringers and with their tops level with the tops of the floorbeams are crossbeams which are 6-in., 12.25-lb. I-beams, spaced about 2½ ft. c. to c. The alternate ones are 20½ ft. long and carry the roadway joists only, while the others are 33 ft. 11 ins. long, the full width of the bridge, the outer ends resting on shelf angles riveted to the lower stiffening trusses. On these crossbeams rest four lines of 9-in., 137-lb. grooved street car rails, secured to each crossbeam by two cast iron clips, each one held down by two ⅝-in. bolts. Between each two rails, are three lines of 6 × 6-in. white oak joists, to which the 3-in. white oak roadway planks are spiked. The sidewalk planks are 2 ins. thick, and the two lines of joists are 2 × 8 ins., blocked up to give a curb 4 ins. high. Under each curb is a line of 6 × 12-in. white oak timbers, laid flatwise, secured to each alternate cross beam by a ⅝-in. bolt and carrying 3-in. blocks spaced about 2½ ft. c. to c., on which rest a line of 2 × 10-in. plank, to which are spiked the sidewalk planks. On the sidewalk planks are 3-in. blocks about 5 ft. apart, carrying a line of 10 × 10-in. white oak timbers, which are secured by ¾-in. bolts, about 5 ft. apart, extending down through the 6 × 12-in. timbers. The 10 × 10-in. timbers were placed there at the expense of the Pittsburg Railways Co., to prevent a car from running off the bridge in case of a derailment. That accident happened

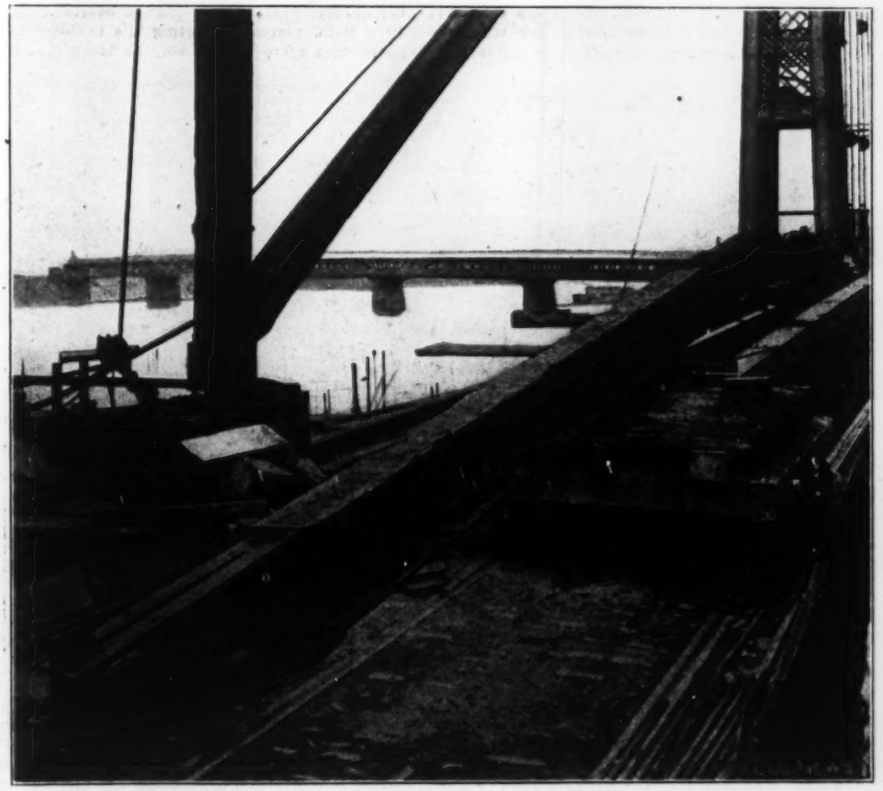


FIG. 8. VIEW OF END SPAN FLOOR BEAM, SHOWING CORROSION.

on a high viaduct a few years ago in this city and several people were killed. Since then they have put heavy guard timbers on the curbs of all the deck bridges which their cars cross.

The new hangers which connect the floor system to the chain above are built of four 3½ × 3½ × ⅝-in. angles, latticed together and riveted at the top to a 3 × ⅞-in. bar bent edgewise and passing over the pin in the chain. The lower end of each hanger is riveted to a ⅜-in. gusset plate, to which the stiffening truss and the floorbeams are riveted. Cross struts, built of four 3 × 3 × ¼-in. angles are riveted between these hangers, the lower ones giving a clearance of 16 ft. above the roadway, with one also halfway up the hanger wherever the length of the hanger is such as to require it.

Fig. 7. View of Anchor Chain, Showing Good Condition of Bars and Absence of Mortar Between Them.

The sway rods are 1 in. square, with a clevis nut at each end. There is a strut between the chains at each panel point, so it was not considered necessary to place one also on the hanger at the top. The length of the hangers were so fixed as to give the desired vertical curvature to the roadway. This involved lowering the floor in some places and raising it in others, thus distorting the lower stiffening trusses. Initial strains in these were eliminated by cutting every diagonal loose at one end, and when the load on the bridge was uniform the holes were reamed and new rivets driven. The upper stiffening trusses were not changed except that a few of the top chord splice plates that were the worst bulged by rust were replaced with new ones.

The lower stiffening trusses were reinforced on the top flange by riveting an 8-in., 11.25-lb. channel on top, with the flanges turned down, and also driving two additional rivets in each end of every diagonal.

The top cross struts between the towers were repaired by cutting out the intersection rivets in the lacing bars—many had been forced apart by rust—and cleaning out the bottom channels—the flanges were turned up—and filling them with concrete so that they would not hold water. The saddles on top of the towers were filled with concrete and also the cells of the 12-in. box girders under the rollers. Concrete was also placed in the bottoms of the 5-ft. box girders under them, so as to make it impossible for water to stand on any of the ironwork. The frames which supported the old ornamental work on the towers were cut away, a new finial was placed on each, and a line of cresting was bolted to the top of each upper cross strut, between the towers.

The bottoms of the towers were repaired by riveting a ⅜-in. plate to each web of each post, the plates being planed on the bottom end and the holes in the posts drilled in such a way as to draw the planed ends of the plates firmly against the base casting, which projected far enough beyond the old ironwork to give a good bearing. As the 10 × ¾-in. plates connecting the bottoms of the posts were corroded so badly as to be practically useless, 63½ × ⅜-in. plates with single 3½ × 3 × ⅜-in. flange angles at the top and single 5 × 3 × ⅜-in. angles at the bottom were riveted across from one post to the other as near the bottom as possible, the lattice work being cut away to make room for it. The bottoms of the columns were filled with concrete and concrete fenders were built against the bases on the outside. This should protect them thoroughly for many years.

The side spans were repaired by removing everything except the trusses, erecting a new truss in the middle between them, and putting in new bracing and a new floor system. The top chords are composed of 15-in. channels and 20-in. co-

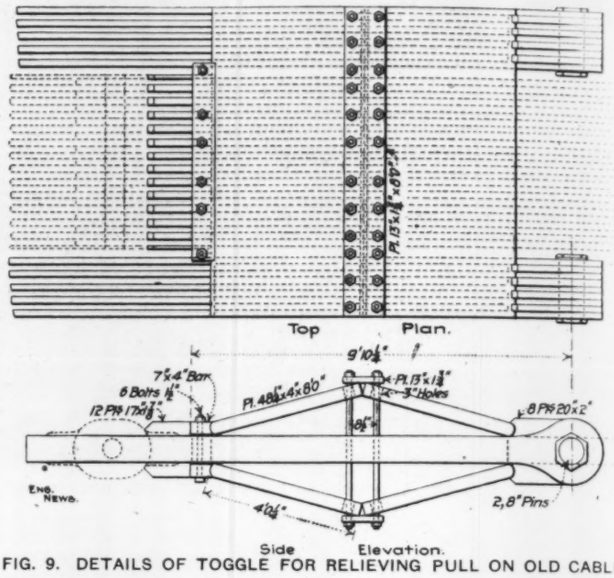


FIG. 9. DETAILS OF TOGGLE FOR RELIEVING PULL ON OLD CABLE.

plates; the posts are some 12-in. and some 15-in. channels laced together; the bottom struts are four 3 × 3 × ¼-in. angles laced together; the top and bottom laterals are all of 3 × 3 × ¼-in. angles, and the sway rods are 1 in. square with a clevis nut at each end. The floorbeams are 2 ft. ¾-in. deep, with 4 × 3 × ⅜-in. flange angles and 5-16-in. webs. There is a line of 12-in., 31.5-lb. I-beam stringers under each rail, and a line of 12-in., 20.5-lb. channel stringers under each sidewalk. The bottom chords and diagonals are eye-bars. The remainder of the floor system is the same as on the main span. The old railing was repaired wherever found defective and replaced.

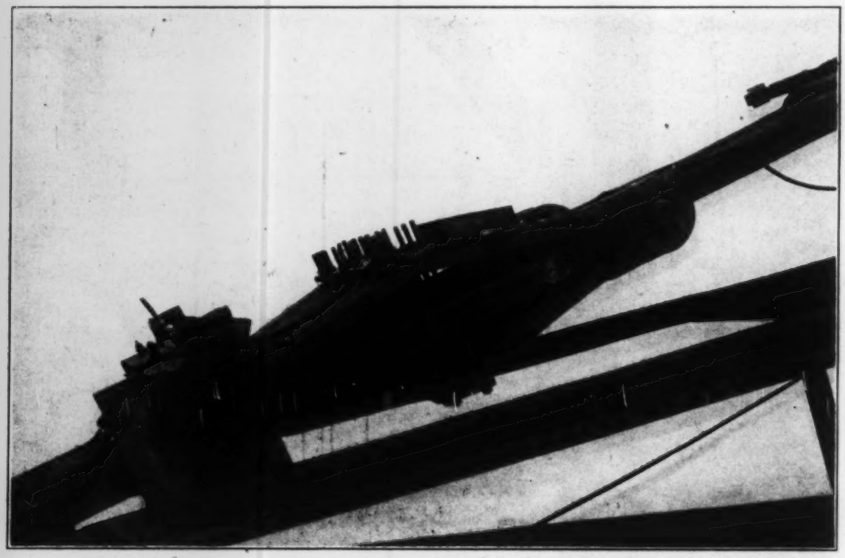


FIG. 10. VIEW OF TOGGLE READY TO TIGHTEN.

MANNER OF EXECUTING THE WORK.

The side spans were erected without falseworks. A large derrick was bolted to the tower, and another was set upon the abutment as close to its face as possible. After the wooden flooring had been removed, and after guying the old trusses with ¾-in. wire ropes, everything was removed from between them except the floorbeams. The top chord was laid out on the floorbeams, and the remainder of the truss connected to them and pinned up, the floorbeams having been shifted enough to clear the new web members. The truss was then raised enough by means of jacks to clear the old floorbeams, which were removed, the new truss jacked down into place, and the remainder of the steelwork erected in the usual way.

The steelwork in the main span was also erected without falsework, blocks being attached to the chains or to the upper stiffening trusses, the old work removed and the new work erected panel by panel. An engine and swing-saw frame were installed to cut the plank for the roadway, and the lumber, which came in barges, was unloaded with a wire cableway.

The holes for the anchorages were dug by hand, the material being hoisted up in skips with a steam derrick, run out on cars to the near end of the main span, lowered with a derrick into barges and towed away. The sand and gravel for the concrete was brought in barges, and the cement, which had been stored near the end of the bridge, was lowered to the same place; the whole mixed by hand on a special barge, hoisted up in skips with a derrick, run down to the end of the bridge on cars and lowered into place with a derrick. The soil encountered was, to a considerable depth, ashes, with some blast furnace slag, and miscellaneous filling material, below that clay, and below that fragments of bluestone and shale, which had slid down from a neighboring hill. Some of the fragments, lower

down, weighed several tons. As explained above, the largest ones that were found near the bottom and only partially in the excavation were allowed to remain in place and were built in with concrete. The sheeting used was 3 × 8 to 10-in. beech plank; the wales 8 × 16-in. and 12 × 12-in. yellow pine and the cross braces mostly 12 × 12-in. yellow pine. Very little water was encountered in the excavations. In building the pedestals at the south end, which are of concrete, the forms were lined with 2-in. dressed and matched yellow pine. The concrete in the new anchorages was filled in up to within a foot or two of where the new chains were to come, making a good bond with the old masonry, as described above. That bond, however, would prevent the masonry from lifting up, but might not prevent it from sliding. It was, therefore, not deemed prudent to remove any considerable portion of the old masonry until that concrete was in place and set. As an additional precaution, only one was connected up at a time, it being considered that the heavy cross walls joining the two sides of the old anchorage would add greatly to the stability of the weakened side. Besides, as much weight as possible had been removed from the main span. Furthermore, as soon as a part of the stone had been removed to a point as low as it was desired to go, the whole was thoroughly grouted with 2 to 1 Portland cement grout. About 600 bags of cement were used for this purpose. It was then considered safe to remove enough of the masonry to allow the new anchors and chains to be put in place.

The toggles were erected as described on the plans, with the 48¼ × 4-in. plates 10 ins. from the old eye-bars at the middle of the toggle, and two ⅛-in. shims were put behind each of the 4 × 7-in. bars. The new chains and anchors were connected and lined up; a block of wood was placed against the bottom end of each anchor and a 30-ton jack against the top. The jacks were then pumped up to their capacity to force the anchors back as far as possible and take up all the slack in the joints. Concrete was then rammed in front of the anchors up to the jacks and allowed to set three or four days, when the jacks were removed and the hole filled with concrete.

Two fine marks 33 ft. apart, the distance accurately measured, were made on the outside of each outer bar and on the top edge of each inner bar of each group of five 8 × 2-in. eye-bars 48 ft. long. The long 1¼-in. bolts in the toggles were then screwed down, drawing the toggles together till those bars had been elongated ⅛-in. in 33 ft. The elongation did not vary more than 0.01-in. in any one of the four. This corresponds to a stress of 9,150 lbs. per sq. in. on the bars, or, as the total section is 160 square ins. to a total stress of about 1,464,000 on each new anchorage pier—assuming the modulus of elasticity to be 29,000,000—in addition to what they received when the jacks were tightened up, which approximated 150,000 lbs. to 200,000 lbs. more. This added nothing to the stress in the main part of the chain; it only reduced the stress in that part of the old chain between the toggle connection and the old anchor by a like amount. The opening of the toggle was then measured and it was calculated that if the toggles were screwed down close the chain would be drawn ¾-in. The bolts were slacked off, the two ½-in. shims replaced by one ¼-in. shim, the toggle plates screwed together, the elongation of the bars measured again, and the calculation found to be correct. The 1½-in. bolts were then cut off about flush with the nuts, and the operation was repeated on the other side. The erection of the steelwork on the main span was mostly delayed until both toggles were finally secured, as it was not considered prudent to put the additional stress on the chains any sooner.

The work on the spans was then pushed rapidly to completion and the new pedestals built of concrete, as shown on the plan, Fig. 11.

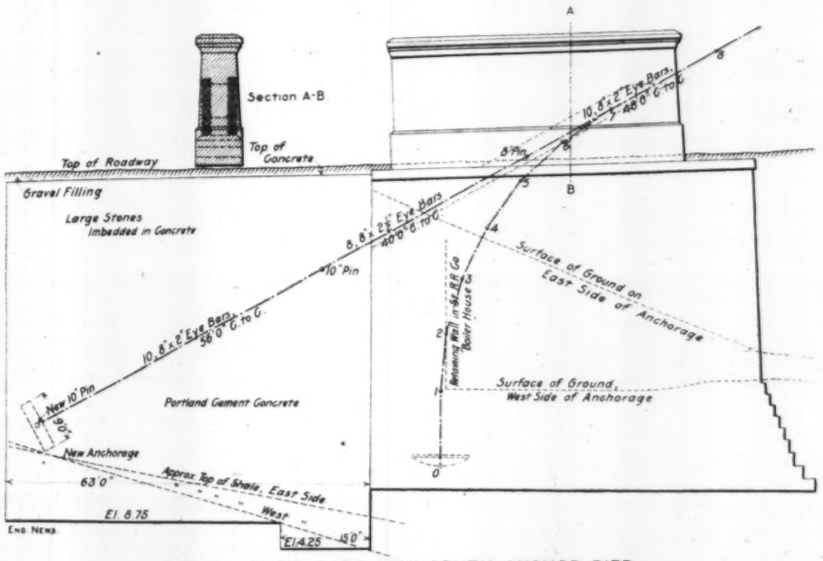


FIG. 11. DETAILS OF NEW SOUTH ANCHOR PIER.

The towers of the old bridge were quite elaborately ornamented with galvanized sheet iron. This was gradually wasted away with rust and pieces occasionally fell down. As this was dangerous to people using the bridge, it was all torn down in 1900 except some of the framework supporting it. Whenever the appropriation for repairing the bridge became available, bids were called for for constructing new ornamental work, each bidder to furnish his own design, the contract price not to exceed $2,000. The design of W. N. Kratzer & Co., of Pittsburg, was accepted on account of its neat appearance and substantial character.

The whole structure was cleaned and given three coats of paint, the first a red lead paint, and the other two 60% of white zinc and 40% white lead tinted to a pale cream color. The old masonry was all repointed.

The contractor for the repairs to the bridge was the Pittsburg Construction Co., M. H. Rankin, superintendent of masonry and timber construction; Lee Trower, superintendent of steel construction, and C. L. McKenzie, President, who sublet the manufacture of the eye-bars to the Phoenix Bridge Co., of Phoenixville, Pa., and the manufacture of the other steelwork to the McClintic-Marshall Construction Co., of Pittsburg.

Work was commenced on the bridge May 31, 1904, and traffic was fully resumed on Dec. 8, 1904.

The work was done under the immediate supervision of the author as Assistant Engineer Department of Public Works; A. W. Burk, Superintendent Bureau of Construction, and E. M. Bigelow, M. Am. Soc. C. E., Director Department of Public Works.

THE INLET SWAMP DRAINAGE DISTRICT IN ILLINOIS.*

By A. M. Shaw.†

The Inlet Swamp Drainage District comprises about 30,000 acres of swamp and low land in the eastern central part of Lee County, Ill. About three-fourths of this acreage was originally included in the Inlet Swamp.

A typical section of the upper soils would show 15 to 24 ins. of black vegetable loam, 36 ins. of yellow or yellow and blue clay, and under this sand and gravel. The natural fall of the surface varies from 1 ft. in three miles near Inlet to 10 ft. to the mile at the eastern extremity of the district.

The order creating the district was entered Aug. 5, 1887. Mr. A. E. Rutledge, of Rockford, was the first engineer employed by the commissioners and he remained as engineer for the district until the completion of the original construction work. In 1896 and 1897 the main ditch was enlarged and extended to Binghampton. It now has a bottom width of about 30 ft. and is 5½ miles in length. It has a fall of a trifle over 1 ft. to the mile.

The following figures, though approximate, are very nearly correct:

Area of district	30,000 acres.
Taxable value of lands in 1886	$183,769.00
Estimated sale value of lands in 1886*	300,000.00
Estimated sale value of lands in 1905*	2,100,000.00
Increase in land values	1,800,000.00
Cost of drainage work to date	197,000.00
Average cost of drainage per acre	6.57
Maximum cost of drainage per acre	10.50
Length of main outlet ditch	5½ miles.
Total of all ditches	57 miles.

*These are exclusive of improvements.

The above figures apply only to the work done by the drainage district. A number of small ditches have been dug by private enterprise and a large amount of tile has been laid. Practically all of the land of the district must be provided with artificial sub-drainage before it can be cultivated to the best advantage. Owing to the varying depths of the porous sub-soil in different parts of the district there is a wide variation in the cost for tiling, but it is probable that $5 per acre would be a fair estimate of the average cost.

The principal difficulties with which the district now has to contend are as follows:

(1) Excessive fall in the upper reaches of tributaries (amounting in some cases to 10 ft. per mile), causing erosion of banks, cutting of new channels and destruction of crops and damage of fields from deposits of sand and gravel at times of overflow.

(2) Lack of fall in the main ditch and lower tributaries impeding the flow and causing deposits of sediment.

(3) Insufficient width of lower tributaries and main outlet, further checking the flow and causing backwater and overflow of the lower portions of the swamp during wet seasons.

(4) Growths of willows along and in the ditches. In some localities these have done considerable damage by causing the ditches to fill.

(5) Caving of banks and waste banks. This caving material forms bars which either retard the flow or deflect the current so that it attacks the opposite banks.

The first mentioned problem, due to excessive fall, affects only a limited area, but is demanding prompt attention as the ditches in this portion of the swamp are cut down into the gravel sub-soil which washes out very fast. Willow poles and matting will doubtless be sufficient to prevent the cutting of the banks, though it may be necessary to do a small amount of rip-rapping. The lack of fall is, as in many drainage projects, the most serious obstacle and one which cannot be entirely overcome. In most districts of this nature there is some point where the speed of the current will be slackened; in the Inlet District this point unfortunately comes near the point of convergence of several of the large tributaries. A ditch of sufficient cross-sectional area to carry away the water as fast as it can be delivered by these ever-increasing tributaries would be of enormous size, probably much larger than the land owners would be willing to pay for. A plan which is now being considered for giving greater carrying capacity to the main ditch is a combination of enlarging and deepening the main channel a reasonable amount and the installation of a complete system of levees along the lower portion of all tributaries. These levees are to be set far enough back to form a waterway that will be sufficient to prevent overflow during the heaviest storms. They should be extended in unbroken lines and their maintenance should be under the direction of the drainage commissioners.

The willow question has received little attention until very recently, but it has here been discovered to be of considerable importance. In many cases, the willows planted along the edges of ditches have spread to such an extent as to greatly restrict the channel, while branches dropping from them have floated in the stream for a distance and finally became lodged and taken root in the bed of the stream. In one of our larger ditches a willow thicket was removed last season that extended for nearly

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, at Chicago, Jan. 18, 19, 20, 1905.

†Contracting Engineer, Dixon, Ill.

half a mile, covering the entire bottom of the ditch. Last year the court authorized an annual appropriation for establishing a regular patrol of the district, and the removal of willow brush and small willow trees from the ditches will be one of the duties of this patrol. A vigorous campaign against the willow hedges has been begun by the commissioners and it is now receiving quite general assistance from the land owners.

Caving banks we have always with us. It would be difficult to find a ditch dug more than five years ago, where the banks are still in their original position on both sides of the ditch. I do not recall seeing a set of specifications for drainage ditches that did not call for a slope of at least 1 to 1, nor do I recall seeing a single piece of work done in the ordinary way with a dipper dredge, that had such a slope. Fairly good slopes are dug by railway steam shovels in cuts not exceeding 10 or 12 ft. in depth. Why cannot the same result be obtained in drainage ditches? I am afraid that the extreme persuasive powers of contractors have something to do with this. How often has the generous contractor offered to take out even more than the required yardage without extra compensation, if he may be allowed to dig his ditch with vertical banks. No great study is necessary to find the results; which will be frequent caving of the banks, restriction of the stream at that point; or, worse yet, the transportation of the material to some point where the carrying capacity of the ditch is already overtaxed, and the formation of a bar where the current is checked. Little material encountered in drainage work will stand at a slope of less than 1 to 1 if subjected to the action of weather and running water, and most material requires a slope of 1½ or 2 to 1 for a permanent slope. Railway men demonstrated this to their own satisfaction years ago, while those in charge of projects more closely resembling drainage work (such as levees and canals) have adopted slopes of 2 or 3 to 1.

I submit the following as my ideal of a 6-ft. drainage ditch requiring a cross-sectional area of 75 sq. ft. for ordinary flood water and twice that for maximum flood water: Depth, 6 ft.; bottom, 1 ft.; slopes, 2 to 1; top, 25 ft.; berm, 8 ft. Waste banks to be dressed down to a height of 2½ ft. and sodded. The waste banks and berm could then be used as pasture or hay land, but should never be cultivated.

Various methods were employed in the construction of the smaller ditches, some of them being dug by hand or by teams and scrapers, but the bulk of the work was done by dipper dredges on barges. The contracts for the heavy work were let at 10 to 11 cts. for earth, and 80 cts. for solid rock.

The machine that I have been operating during the past season represents a comparatively new type. It is a land machine known as the Jacobs steel excavator. In working position, the machine spans the ditch, the digging being done by two buckets which travel across the line of the ditch on adjustable runways or guides. My machine, as adjusted at present, will dig a ditch 8½ ft. deep with a 6-ft. bottom and slopes of 1½ to 1. It can be adjusted to any slope or width up to a top width of 33 ft. The buckets take out a cut of 4 ft. in width at each move. The feed of the buckets is controlled by four screws which are geared to the engine by link belts. While one bucket is traveling up the runway and dumping, the guides are lowered by the screws so that a full cutting is taken by the returning bucket.

The work that I had last season was the construction of a ditch with 6-ft. bottom and slopes of 1½ to 1, average depth, 5 ft. The route followed an old ditch for a considerable distance which made it necessary to do some blocking. The yardage was of course reduced by this old ditch. Under these conditions the actual cost of the work, including running repairs and all other incidental expenses was practically 7 cts. per cu. yd. Under more favorable conditions and with heavier work, this price could be very greatly reduced.

STEEL FRAMEWORK OF THE NEW LOCOMOTIVE REPAIR SHOPS OF THE LEHIGH VALLEY R. R. AT SAYRE, PA.

By D. C. N. Collins,* M. Am. Soc. C. E.

The following article describes the steel framework of the buildings for a large new locomotive repair shop of the Lehigh Valley R. R. at Sayre, Pa.† It is the intention to limit this article to the established data that governed the design and detailing of the steelwork. The general description and uses of the structure will, in consequence, include only such information as relates to the development of this part of the work.

The ground covered by the four buildings described herein amounts to about 379,000 sq. ft., or nearly 8¾ acres. The Main Locomotive Shop alone, 360 × 749 ft. in plan, covers over 274,000 sq. ft., or 6⅓ acres. The Blacksmith Shop and the Storehouse are each 103 × 363 ft., and the Power House is 125 × 240 ft.

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†For a general outline of these shops, and a plan and general sections of the buildings, see Engineering News of June 25, 1903, p. 570.

MAIN LOCOMOTIVE SHOP.

The accompanying Fig. 1, a general drawing of the steelwork of this building, shows the symmetrical and uniform layout of the work; the building is of such size that only a part plan is given. This will serve, however, to show the general features of the design. The remainder of the building is a continuation of that shown, with minor modifications.

The two outside bays have a clear height of 50 ft. to the bottom chord of the trusses and are used for general erecting purposes and for boiler work. The entire central portion of the building, between the erecting shop bays, has a clear and uniform height of 34 ft. 4 ins. to the under side of the roof girders, which carry a regular system of skylights of the saw-tooth type, having the glass inclined toward the north at an angle of 60° from a horizontal line. The gallery in the center bay has its elevation fixed at 21 ft. 6 ins. above the main floor and is intended for the convenient disposal of the heating appliances, lavatories and lockers, and for light storage. This leaves the three center bays with a clear floor for machine shop purposes. The bay on each side immediately adjacent to the erecting bay is intended to form a covered yard.

The length of this building is 749 ft., divided into 30 bays or panels of 24 ft. each, and having one-half panel at each end of the building which can be removed when future extensions are decided upon; all details and sizes are designed with this in view. The brick walls surrounding the steel frame rest upon their own foundations and are independent of the steel frame except that they are anchored to the heavy lower sections of the wall columns and are built in between the flanges of the upper section of these posts. The gable walls all run above the finished roof to afford protection against fire and to present a better finish architecturally. All roofs are covered with reinforced cinder concrete built to provide for expansion and covered with tarred felt roofing and granulated slag.

The two erecting shop bays have a monitor running the full length of the building with pivoted sash on the sides inclined at an angle of 60° from the horizontal. The vertical sides of the erecting shop, above the saw-tooth portion, are covered with pivoted and fixed sash surrounded by reinforced cinder concrete slabs on steel siding. The gallery floor is of reinforced cinder concrete also.

The riveting tower, in the boiler shop section of this building, obtains the requisite clear height by adopting a pit riveter without the necessity for running up the building into an unsightly tower as is generally done.

The main posts throughout this building are left open, for convenient inspection and painting from time to time, except near the floor where they are boxed in with steel plates; these boxes are filled with concrete having the top sloped off to such a pitch as to prevent the possibility of an accumulation of dirt, waste or other inflammable material.

ASSUMED LOADS.—The roof is assumed as weighing 75 lbs. per sq. ft. of horizontal projection, which assumption includes the dead weight of material and the weight of snow and wind pressure. The saw-tooth roof is, however, calculated for 85 lbs. in view of the probability of large masses of snow accumulating upon it.

Two end trusses in each erecting shop bay are made heavier to permit of lifting the crane crab from the bridge; the extra load here was taken at 50,000 lbs. concentrated at any point on the bottom chord of the trusses, in addition to the above assumed roof load. All girders under the saw-tooth portion, in line with these special trusses, were also increased in section by an assumed load of 16,000 lbs. at any point on the bottom chord for the same purpose. In the south end of one of the erecting bays the regular roof trusses were omitted and heavy box girders of exactly the same profile were substituted (see Fig. 4); they were designed to carry, in addition to the regular roof load, a special riveting tower crane of 20 tons capacity on a runway provided for it on the side of each girder. This crane has 2 two-wheel trucks with a maximum load of 32,000 [illegible] each wheel and a wheel base of 6 ft.

The gallery load was assumed at 200 lbs. per sq. ft. of floor for the live load; the [illegible] load was 240 lbs. per sq. ft., and special [illegible] and framing introduced for the support [illegible] heating equipment where required.

CRANE LOADS.—The upper craneway [illegible] two erecting shop bays is designed to [illegible] electric crane of 120 tons capacity for lifting a locomotive bodily over others and to set it over the pit selected for its repairs. These [illegible] have two four-wheel trucks with wheels [illegible] ft. on centers, making a total wheel base of [illegible] and a maximum load of 87,000 lbs. on each [illegible] The crane rails here used weigh 150 [illegible] per lineal yard.

The lower cranes in the erecting shop [illegible] as well as the two 60-ft. span cranes in the [illegible] shop, are of 15 tons capacity having two [illegible] wheel trucks with a wheel base of 10 ft. and an assumed maximum load of 35,000 lbs. on each wheel; the 15-ton cranes in each of the 12 ft. bays are like the other 15-ton cranes except the wheel loads, which were assumed at 30,000 lbs. All rails for the 15-ton cranes were of a weight of 58 lbs. per lineal yard.

WORKING STRESSES.—The working stresses of all steel were based on a soft-medium grade with a desired ultimate strength of 60,000 lbs. per sq. in., tests to be confined within limits of 5,000 lbs. above or below this amount. Rivet steel was to be of a soft grade with a desired ultimate tensile strength of 50,000 lbs. The phosphorus limitations were 0.08% for acid and 0.04% for basic manufacture, and the sulphur limits were 0.05% for all grades of soft-medium material. The soft grade of steel was restricted to 0.05% in both phosphorus and sulphur. The specifications also called for the necessary tests and inspection of all material to insure its being of the best quality for the purpose.

The following working stresses were used:

Tension members, 15,000 lbs. per sq. in.
Compression members, 12,000 lbs. per sq. in., reduced by the Rankine-Gordon formula.
Crane girders, 12,000 lbs. per sq. in. net section of flanges.
Roller I-beams and channels, 16,000 lbs. per sq. in.
Web shear, 9,000 lbs. per sq. in.
Shop rivets, 9,000 lbs. shear, 18,000 lbs. bearing.
Field rivets and bolts, 7,200 lbs. shear, 14,400 lbs. bearing.
Bearing of steel on concrete not to exceed 200 lbs. per sq. in. under the most extreme combination of pressures.
Concrete bearing on soil not over 2 tons per square foot under the same conditions.

No metal was used in the design of less thickness than ¼-in.

The stresses due to horizontal wind pressure, for convenience in calculation, were proportioned to the working stresses given above and on a basis of wind at 20 lbs. per sq. ft. of vertical projection of surfaces. This is equivalent to the assumption that the extreme possibilities of a uniform pressure of 40 lbs. per sq. ft. should not strain the metal beyond the elastic limit. The thrust produced by the action of overhead crane loads was assumed at a figure high enough to safely meet all requirements. In consideration of the fact that the maximum lateral forces due to cranes and wind would be always of a temporary nature, seldom likely to occur simultaneously with the greatest combination of assumed vertical loads for which ample material is provided, this wind assumption seems to be enough to safely meet the most extreme possibilities.

The given value for proportioning the number of field rivets was purposely taken low in order to provide an excess of strength in all connections that were to be riveted at the site. The data given for the detailing of the work and also for the shop fabrication were sufficiently elaborate and clear to control every detail and all shop drawings were thoroughly checked and approved by the company before being sent to the shops.

STEEL DESIGN.—The building was treated in design as a series of craneways capable of withstanding all lateral pressures and forces, and depending on the lighter roof construction merely as a covering. The main posts were carried below the floor just far enough to bury all obstructions to a clear passageway around them. All posts P 1 and P 2 were anchored to the concrete piers with 4 bolts 2½ ins. in diameter; posts

P 3 and P 4 were anchored each with 4 bolts 2¼ ins. diameter. This anchorage and the sway bracing over the gallery, with the aid of the dead weight of the building itself, are sufficient to withstand the most severe combinations of lateral forces without depending on the brickwork for assistance.

The anchor bolts for all main posts were set in circular metal boxes 12 ins. long and about 4 ins. in diameter, to permit a possibility of adjustment of the tops of the anchor bolts after the concrete masonry hardens. The posts were leveled up on steel wedges and thoroughly grouted to a solid bearing; 2½-in. holes were punched in all base plates of the posts to facilitate the flow of cement grout, and the anchor bolts by this means were firmly secured in position.

Expansion of material due to temperature changes was arranged for laterally by designing the top section of the posts P 3 in two parts, making practically a split post, connected by gussets and slotted holes which allow 2 ins. of space for temperature changes in a distance of 78 ft. (from P 3 to the center of the building) or 102 ft. (from P 3 to the outside of the building). All lateral field connections were riveted except the slotted holes in the top of posts P 3.

Longitudinal stiffness and expansion of material was provided for by a series of braced tower bents, every third panel being braced, leaving two unbraced panels between each. At the point between these two unbraced panels all heavy members were specially designed with expansion joints to allow 1-in. space at each; these expansion joints were 72 ft. apart. The longitudinal roof members were generally bolted together at the building to avoid the expensive, tedious and unnecessary work of inconvenient riveting, except in the braced panels where everything was riveted in order to make the bracing effective. The space allowed for expansion in this light material was assumed as being provided by the accumulated clearances in the many bolted connections.

The girders under the saw-tooth trusses, it may be noted, are not made of an economical depth, because the additional cost of this shallow limit was warranted by the desirability of getting the skylights as low as possible both for their own efficiency and for that of the erecting shop windows beside them. Special saw-tooth trusses were placed in five of the panels that came opposite the heating units; these special trusses were made to allow space for the passage of the large heat pipes. The saw-tooth trusses are uniformly spaced 12 ft. apart.

LINE SHAFTS AND MOTOR BRACKETS.—The original layout provided for continuous line-shafts located under the crane girders at posts P 3 and also under the center of the gallery girders, three shafts in all. These line shafts were each to be driven by seven motors, so arranged that one motor can drive the entire shaft and others be coupled in as needed. The crane girders at posts P 3 are specially studied as regards lateral and vertical deflection and are arranged to carry the hangers for support of the main shafts to be secured to wood ties clamped to the bottom flanges of the two girders. The motors are located on steel brackets on the posts about 12 ft. above the floor. Each motor was assumed to weigh 7,000 lbs. Brackets for the jack-shafts are placed on all posts P 3 and P 4, under or near the main shafts, and three longitudinal 12-in. I-beams are provided on each row of them for the convenient fastening of wood ties to carry the jack-shaft hangers. These jack-shafts are driven by belt from the main shafts and will admit of changes ad libitum in belting to any number of small machines. For convenient adjustment, these brackets were all made in duplicate so that the motor brackets can be located or changed as occasion directs. Fig. 2 shows the location and dimensions of the brackets. They are shown in position in the view Fig. 5.

OTHER DETAILS.—The erecting shop roof is framed with light angle trussed purlins running longitudinally, each well braced from the bottom chord of the roof trusses to prevent vibration. They carry 7-in. channel rafters 6 ft. on centers, on which the concrete roof slab is laid. At the outside eave a 9-in. channel is located, both to afford a permanent longitudinal tie and to provide temporary support for the rafters.

The saw-tooth trusses connecting to posts P 3 and P 4 are made with a bottom chord composed of two 6-in. channels to afford additional tie and bracing to these posts.

Four loading platforms, or pulpits, are located along the gallery floor, in size 6 × 8 ft.; they are designed to carry a live load of 200 lbs. per sq. ft. Framing for eight flights of circular stairs was provided in the gallery floor framing, also all necessary steel ladders to afford access to the crane cages, to the roof and for cleaning skylights.

The crane girders were proportioned with liberal width of top chord and were reinforced to better withstand the tendency to lateral deflection due to the action of moving loads. They were carefully arranged to be free from connected bracing so that they are at liberty to deflect vertically with the minimum amount of vibration to the structure. All stiffeners are straight angles on fillers and bear at top and bottom to afford the best support for the wheel loads. These girders are all riveted in solid in all braced bays and have riveted connections even at the expansion points.

BLACKSMITH SHOP.

This building is arranged with the roof trusses in one span of 100 ft. The trusses

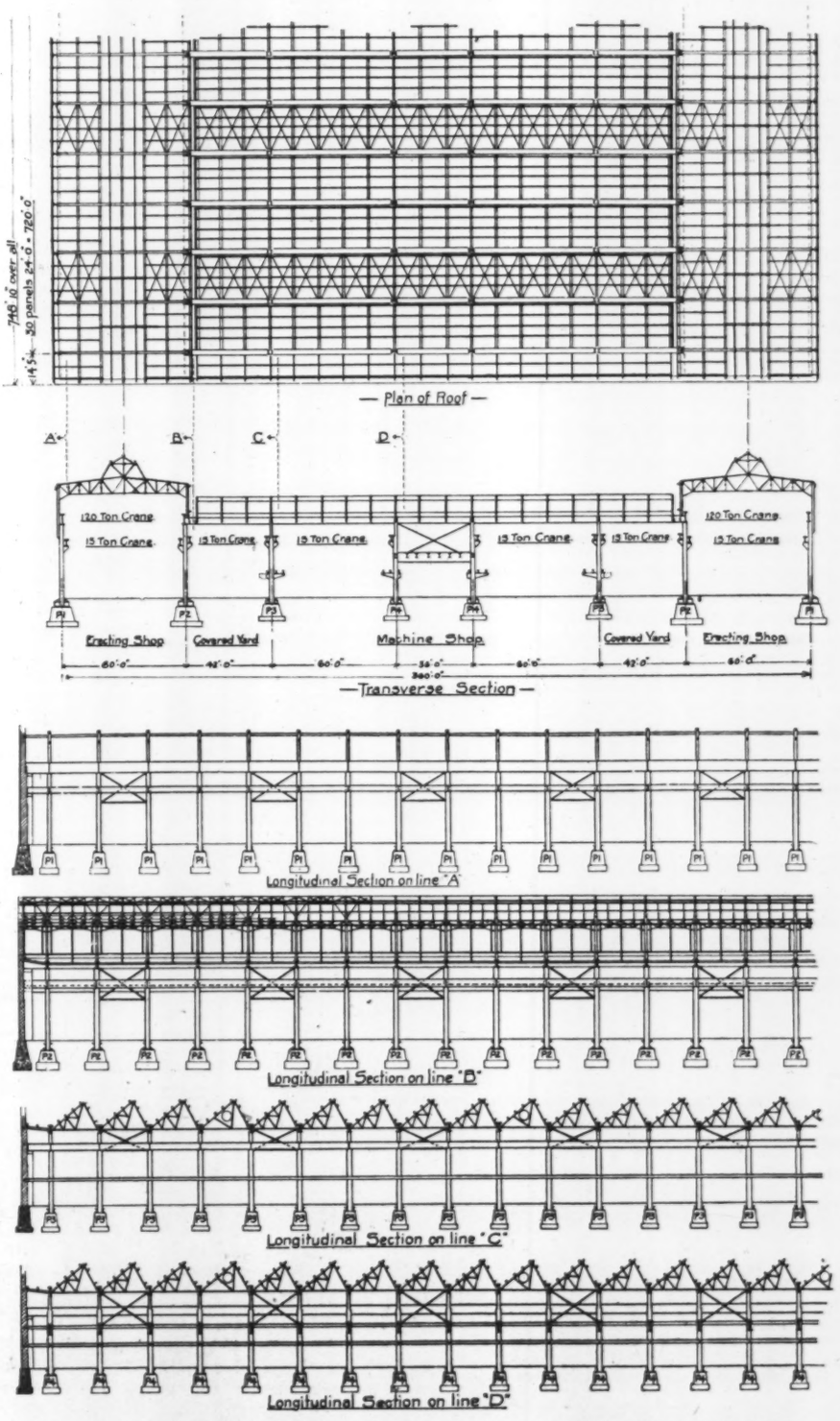

FIG. 1. PART PLAN AND REPRESENTATIVE SECTIONS OF MAIN LOCOMOTIVE SHOP; LEHIGH VALLEY LOCOMOTIVE-REPAIR SHOPS, SAYRE, PA.

are anchored at each end to stone blocks built into the walls. The clear height to the bottom chord of the trusses is 20 ft. No provision for expansion was made in a lateral direction as it was considered safer to require a wall 20 ft. high to accept this duty rather than to expect it to withstand the pushing and pulling of a loose roller bearing that might gradually creep off its support and cause disaster. The roofing material is the same as that on the main shop, slag on reinforced concrete.

In this shop no material was used of less thickness than 5-16-in., on account of corrosion, and the bottom chords of the trusses were made stiff and heavy to provide support for concentrated loads likely to be hung upon them.

A monitor with sash, skylights and louvres runs the full length of the building and this is also provided with ventilation at the extreme peak by means of an additional small monitor with open louvres. An I-beam trolleyway is located through the building, to be equipped with a triplex block and trolley.

No provision is made in the roof framing for the lateral support of the future jib-cranes as their exact location was difficult to determine. Iron blocks were therefor set into the walls under each roof truss bearing, and the bearings themselves were detailed to provide connections for any future system of rod bracing that may be needed.

The gross roof load was assumed at 80 lbs. per sq. ft. Three panels of rod bracing are introduced in the roof framing to stiffen things generally. All holes necessary for fastening wood, glass and other material were punched in the steel shops before erection.

STORE HOUSE.

The building is divided into two of equal size, by a tranverse fire The north half is equipped with transvers power cranes of 5 and 15 tons capacity. T trusses are designed to carry a gross load lbs. per sq. ft., and the trusses are suppor two rows of posts running longitudinally as by the outside walls. A liberal monitor vided through the center with ample light.

The clear height of the building to the chord of the trusses is 17 ft. above the flo 21 ft. above the top of the pit rail. Latera ing is called for in the roof to counteract t fects of lateral pressures and the action

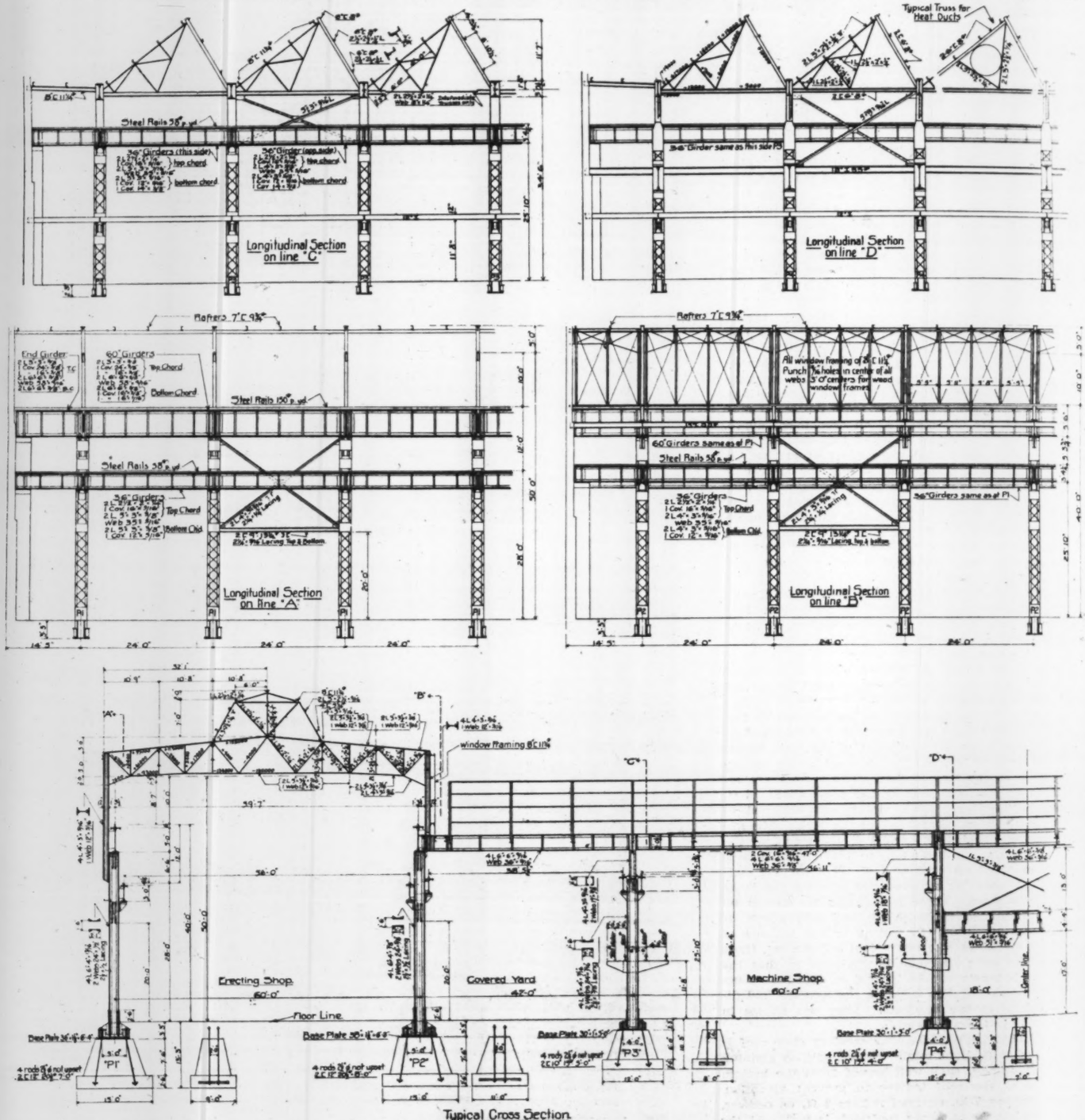

FIG. 2. DETAIL SECTIONS OF MAIN LOCOMOTIVE SHOP.

cranes. Steel ladders were provided to afford convenient access to the monitor and to the roof.

POWER HOUSE.

The roof trusses here rest upon, and are anchored to, the brick walls at the sides of the building as well as to the center longitudinal fire wall. They are designed to carry a gross load of 85 lbs. per sq. ft. in addition to 2,000 lbs. concentrated at any point on the bottom chord. The boiler house trusses have in addition to this a load of 4,000 lbs. on the bottom chord at the center as the assumed weight of a coal conveyor.

A monitor with sash on two sides and two separate rows of skylights are introduced over the boiler house; portions of the skylights are movable for the convenient removal of upright boiler tubes. The engine house has one row of skylights. One 20-ton crane with two two-wheel trucks is located here. The wheel base is 10 ft. and the assumed load on each wheel 38,000 lbs.

The engine house floor is calculated to carry a live load of 400 lbs. per sq. ft. in addition to the weight of the floor material. Grillage is included for the support of boilers, etc., over the smoke flues and also for the support of the coal pockets which have posts located over the flues or tunnels.

Two steel coal pockets are built in the boiler house with a capacity of 200 tons each. They have hopper bottoms and are plate lined. The ash-bin and coal-conveying tower is of steel and has a reinforced cinder concrete roof covered with tarred felt and granulated slag. The sides are covered with corrugated, galvanized iron. Each of the two ash bins has a capacity of 3,000 cu. ft. and is lined with reinforced cinder concrete. This tower also includes supports and facilities for fastening all coal conveyors, ash hoists and for the convenient loading and unloading and crushing of coal.

The roofs of all buildings in this group have the same covering of reinforced cinder concrete covered with tarred felt and granulated slag. All holes were carefully incorporated in the original design for the fastening of the work of other trades so that they could be punched at the shops rather than have to undergo the tedious and expensive process of drilling in the field. All stresses and sizes of material were carefully and fully shown on the plans side by side to facilitate the ready completion of the work; all governing sizes of members and of connections were thoroughly fixed at the start for the use of the various trades; all details of the shop work were promptly checked and approved to avoid delay. The work was then quickly, accurately and satisfactorily executed in the shops of the American Bridge Company.

The steelwork was designed and the steel construction checked and approved by the writer, under the direct supervision and general approval of Mr. Walter G. Berg, Chief Engineer, and Mr. E. D. B. Brown, Architect, of the Lehigh Valley R. R. The details of the shop and field inspection of material were in charge of Mr. F. E. Schall, Bridge Engineer of the railroad company.

FIG. 3. VIEW IN ERECTING BAY OF MAIN LOCOMOTIVE SHOP DURING CONSTRUCTION.

FIG. 4. END OF ERECTING BAY OF MAIN LOCOMOTIVE SHOP, SHOWING BOX GIRDERS FOR RIVETING CRANE.

ANNUAL CONVENTION OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.

The 20th annual convention of this Society was held at the Sherman House, Chicago, on Jan. 18, 19 and 20, and was the largest and most successful meeting in the history of the Society. The report of the Secretary and Treasurer showed a membership of 134, and 40 new members were elected, making a total of 174. This will be reduced to a net membership of about 150 by the action of the Executive Board in deciding to drop members who are two years in arrears and fail to pay their dues within 30 days of a final notice. The cash balance in the bank on Jan. 17, 1905, was $287, as compared with $206 in January, 1904.

At the opening meeting on Jan. 19, at 2 p. m.,

FIG. 5. SHAFTING BRACKETS ON COLUMNS OF MACHINE-SHOP BAY, MAIN LOCOMOTIVE SHOP.

FIG. 6. VIEW OF STOREHOUSE DURING ERECTION.

a brief address of welcome was delivered by Mr. S. S. Greeley, one of the veteran surveyors of Chicago, and this was followed by the address of the president, Mr. J. W. Alvord, who reviewed the history and development of the Society.

LAND DRAINAGE.

This is a subject of special interest and importance to engineers in the Middle States, and is always one of the subjects taken up at these meetings. The first paper was by Mr. J. G. Melluish, and dealt with "Drainage in Western Iowa," under the new law of May, 1904.

This statute provides that a petition signed by one or more land owners interested shall be filed with the county auditor, with a bond sufficient to cover the costs if the petition is refused by the Board of Supervisors. The Board appoints an engineer to make a survey and report, with estimates and recommendations. If the Board considers these favorably, property owners are notified and a time appointed for hearing their claims. Claims for damages are adjusted by a jury of three freeholders, after which the Board declares the drainage district established, divides the improvement into sections, and advertises and lets the work. An engineer of construction is appointed, who is required to give a bond for the faithful performance of his duties, and the administration of the improvement rests with the engineer.

A paper by Mr. A. B. Alexander discussed the question of "How Tile Drainage Improves a Soil," showing the effect upon soils of different character. There was also a report from the Committee on Drainage. In the discussion, Mr. T. S. McClanahan showed that tile drainage improved land in dry as well as in wet seasons, the moist air from the drains percolating up through the soil in the former case. Mr. W. P. Chase did not approve of requiring engineers to give bonds, as in the Iowa law. A paper on "The Inlet Swamp Drainage District," by Mr. A. M. Shaw, described the drainage of this district of about 30,000 acres in Lee County by means of dredged ditches. An abstract is printed elsewhere in this issue.

A paper on "Schoolhouse Construction," by Mr. F. Oswald, was read by Prof. N. C. Ricker, Dean of the College of Engineering at the University of Illinois.

The evening session opened with a paper by Mr. A. C. Schrader, Chief Engineer of the West Park Board, of Chicago.

THE CHICAGO PARK SYSTEM.

The city having outgrown its park system has authorized the issue of bonds for $6,000,000 for new parks and extensions, particularly in the way of small parks. There are now about 3,600 acres of parks, 2,700 of which are parks proper, the balance being in the boulevards, which are about 50 miles in length. The assessed valuation in 1903 was $399,000,000. An important feature of the new work is the establishment of small parks and public playgrounds throughout the densely populated districts. Mr. J. F. Foster, Engineer and Superintendent of the South Park system, considers that the area of playground should be not less than 10 acres, and if it were not that the cost would be prohibitive he would have this as part of a 40-acre park in each case. The playground should include a ball field large enough for two games, running tracks, sand pits, wading and swimming pools, and an outdoor gymnasium. There should also be a building for an inside gymnasium in winter, with rooms for public lectures, clubs, etc. The South Park Board has 10 of the 12 new parks nearly completed, and the ideas of Mr. Foster have been to a large extent observed in their construction. The buildings are of monolithic concrete, with tile roofs, and cost from $60,000 to $100,000 each.

The city should now begin to provide for an outer belt or park system, beyond the present suburbs: along the Des Plaines River near Riverside, in the Skokie marsh, on the high lands about Willow Springs, and in the Calumet River district. It is also suggested that the city should consider the establishment of a park frontage 600 to 1,200 ft. wide along the entire length of the lake front, reclaiming land where necessary, as has already been done for Grant Park.

Mr. E. E. R. Tratman then briefly described the deep-level tunnel system of Chicago, built for telephone cables, but now to be used for freight transportation.

SURVEYING.

The morning session of Jan. 19 was devoted specially to papers and discussions on city and land surveying. Mr. S. S. Greeley, one of the veteran surveyors of Chicago, gave an interesting address reviewing the history of surveying in that city, and Mr. S. N. Howard presented a paper on "Modern Surveying in the City of Chicago." He referred to the important work done by Mr. W. H. Hedges, Bench and Grade Engineer of the Department of Public Works, in establishing benches and monuments and improving the street grades. This work was the subject of a later paper by Mr. Hedges. In a paper on "The Land Surveyor," Mr. H. H. Bremer outlined the responsibilities of the surveyor's work, showed that there are no requirements as to his qualifications, and suggested a license law similar to the architects' license law which is now in force in Illinois. An interesting paper by Mr. Will Dowell described his practice and experience in "Land Surveying in Northern Missouri." Mr. W. D. Jones read a paper on "Judicial Elements of Surveying," and Mr. L. A. Waterbury described the methods of instruction in surveying at the University of Illinois. Papers on "Office Methods in Railway Surveying," by Mr. W. D. Gerber, and on "City Surveying," by C. C. Stowell, were read by title. The report of the Committee on Surveying suggested that another attempt should be made to secure the passage of a bill providing for the licensing of surveyors.

WATER SUPPLY.

At the evening session, Mr. D. W. Mead gave an interesting address on "Water Filtration," illustrated by stereopticon views, and Mr. C. B. Burdick presented a paper on "Accuracy Tests of Water Meters at Des Moines, Ia." Most of the meters were old, but the degree of accuracy exceeded the expectations. The report of the Committee on Water Works described the various filtration plants now in use in connection with the water supply system of Illinois cities. Mr. D. H. Maury presented an interesting paper on "The New Well and Hydraulic Pumping Plant at Peoria, Ill." This installation is supplementary to the plant described in Engineering News of Jan. 13, 1898, and April 26, 1900.

STREETS AND SEWERS.

A paper on "Brick Paving at Quincy, Ill," by Mr. F. L. Hancock, was read, and some notes are given below. The report of the Committee on Roads and Pavements dealt with brick and other paving, and the discussion turned mainly on the use of fillers, tar or asphalt compositions being generally favored. Mr. Main, City Engineer of Rockford, uses a mixture of tar and sand. Papers on "Tests of Paving Brick," by Prof. A. N. Talbot, and "The Sheridan Road," by Mr. W. S. Shields, were read by title. Mr. W. B. Ewing read a paper on "The Sewerage and Drainage Systems of Wheaton, Ill." The systems are entirely independent; the former discharges at a septic tank plant, and the latter into a large drainage ditch.

BRICK PAVING AT QUINCY, ILL.

The paper by Mr. F. L. Hancock, City Engineer, stated that the first brick pavements in Quincy were laid with a double course of brick on a broken stone foundation, with a sand cushion of 3 to 4 ins. This plan was soon abandoned in favor of a single course of brick with a 3-in. sand cushion and 6-in. broken stone foundation. While this has been satisfactory, even under heavy hauling owing to the excellent subgrade, the stone foundation is not advocated for other localities, and Mr. Hancock favors a concrete base. Unless the subgrade and the stone base are well rolled and the sand watered, the pavement will fail. There is no grouting, but the paving is covered with sand, which fills the joints; cement filling or grouting makes the pavement noisy, but a first-class asphalt filling is approved, as it is sanitary, non-absorbent and flexible.

For repair work, patching should be avoided; it is better to get the limit of wear out of the pavement and then renew it entirely.

STEEL AND CONCRETE BRIDGES.

At the closing session on Jan. 20, Mr. R. D. Gregg, City Engineer of Kankakee, read a paper on the Washington Ave. bridge at that city, which has seven arches of 73 ft. span, and is 46 ft. wide. The bridge is of reinforced concrete, the reinforcement consisting of 1⅛-in. Thacher bars in pairs, one above the other, connected by vertical ½-in. round rods with hooked ends. These ribs are 17 ins. apart, and connected by six sets of transverse ¾-in. Thacher bars, tied to the ribs with wire. The bars are of medium steel of 60,000 to 68,000 lbs. per sq. in., and have a sectional area equal to 1-150th part of that of the arch ring at the crown. The arches have a radii of 21.7 and 97.82 ft. for the intrados, and 107.7 ft. for extrados, with a thickness of 16.1 ins. at crown and 32.6 ins. at the spring. Each built in three longitudinal sections, each of was a day's work. The bridge was designe the Concrete Steel Engineering Co., of New and built by the Marsh Bridge Co., of Des M Iowa.

Mr. T. L. Condron gave a talk on "Reinf Concrete Structures," accompanied by diag and a number of views of bridges, culver taining walls, grain elevators, etc. Mr. F. Ives read a paper on "Highway Bridges an verts"; Prof. Frink discussed the properti "The Queen Post Truss," and the report o Committee on Structural Engineering largely with the design of concrete arches.

RAILWAY GRADE CROSSINGS.

This paper was by Mr. F. G. Ewald, Consul Engineer to the Illinois State Board of Rail Commissioners, and was of special interest on account of the controversy in that State as to the jurisdiction of the Commission in regard to elec tric railway crossings. The Attorney-General holds that its jurisdiction covers such railways. There are 526 crossings of steam railways, of which 215 are provided with protective devices and operated under the authority of the Railway Commission; there are 392 grade crossings of electric railways with steam railways, 19 of which have protective devices, but only three of these are operated under the authority of the Commission. The paper reviewed the several State laws bearing upon this subject.

The report of the Committee on Mechanical and Electrical Engineering reviewed the development of the water power plants on both sides of the Niagara Falls. It stated further that the steam turbine has not made the rapid progress which was anticipated, and that the most important rival of the steam engine seems to be the gas engine in connection with gas producer plants. This combination effects a great economy in coal consumption, not only for large units but even in units of 25 to 50 HP., although the cost of installation is greater than for a steam engine and boiler plant.

ENTERTAINMENT AND EXCURSIONS.

Two very interesting excursions were arranged by the local committee. On the evening of Jan. 18, the party was taken on a trip over the narrow-gage railway in the tunnels of the Illinois Telephone Construction Co., and also to the switchboard in the company's automatic central exchange. This was arranged by courtesy of Mr. Geo. W. Jackson, Chief Engineer and General Manager. On the afternoon of Jan. 19, a trip was made to the new Portland cement plant of the Illinois Steel Co. at Buffington, Ind., by courtesy of Mr. E. M. Hagar, Manager of the company's cement department. The mill buildings are of concrete, and the office and laboratory building is of concrete blocks. The mill has a capacity of 4,500 barrels per day, and has 16 kilns 80 ft. long; the entire plant is driven by electric motors, aggregating 4,000 HP., current at 20,000 volts being transmitted from the company's power station at the South Chicago steel mills, where waste blast-furnace gases are used for fuel. On the evening of Jan. 20, there was a dinner at the Sherman House, about 75 members and guests being present, and this was followed by a theater party.

OFFICERS.

The officers for 1905 are as follows: President, Dabney H. Maury, of Peoria; Vice-President, J. G. Melluish, of Bloomington; Secretary and Treasurer, E. E. R. Tratman, of Chicago. The next meeting will be held at Rockford, Ill., in January, 1906.

ANTI-CREEPING CLAMPS FOR RAILWAY RAILS.

The creeping of rails in railway track is a phenomenon of rather frequent occurrence, and is apt to be specially troublesome at track grade crossings, frogs and switches, and bridges. Various devices are used to hold the rails, and one of the latest of these is shown in Fig. 1 herewith. It consists of a pair of clamps, A A, embracing the edges of the rail base and drawn together by

a bolt under the rail. The face bearing against the edge of the rail is serrated so as to get a good grip and prevent the rail from slipping through, while the lower part of the clamp bears against the edge of the tie, which thus resists any travel or longitudinal movement. Instead of a bolt, a long tie-rod, B, may be used, as shown; this passes through both sets of clamps and serves to hold the rails to gage.

This device is being used on the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul railways, and other roads are giving it a trial. In one case it has been in use for about a year at a grade crossing where the creeping had averaged about 2½ ins. northward in the northbound track and 2½ ins. southward in the southbound track every 90 days; at the end of that time it was necessary to take up the crossing and adjust it in proper position, at an expense which is given as $95 for each time of adjustment. An expenditure of $6 for rail anchors has, it is said, stopped the creeping effectually and eliminated the constant expense for replacing. From 12 to 20 sets of these anchors, or 6 to 10 anchors to each rail, are required to prevent creeping at any point. The device is known as the Racine rail anchor, and is being introduced by the Holland Co., 77 Jackson Boulevard, Chicago.

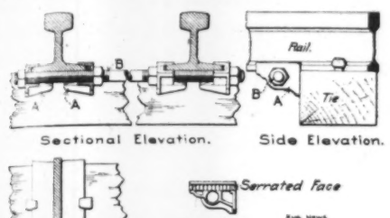

Fig. 1. The Racine Rail Anchor.

Another device for the same purpose is shown in Fig. 2. The horizontal part lies under the base of the rail and is hooked over the edge, while the rail is gripped by a bolted clamp; the vertical part of the plate bears against the edge of the tie. In a modified form, the bolted clamp is dispensed with, and the plate is extended up to lie against the splace bar, where it is secured by one of the bolts of the joint. This is known as the L. & S. anti-creeping device, and is manufactured by the Belle City Malleable Iron Co., of Racine, Wis.

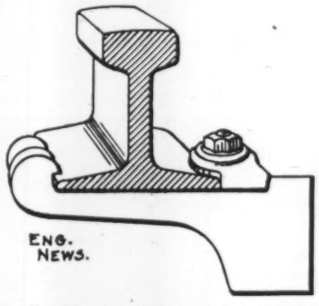

Fig. 2. The L. & S. Anti-Rail Creeper.

THE WORK OF THE ENGINEERING CORPS OF THE DEPARTMENT OF BUILDINGS, NEW YORK CITY.

The extent to which the services of engineers are required in administering the bureau having charge of building construction in a modern large city is almost unknown to the average citizen, and is but partially realized by engineers. For this reason it is interesting to review briefly the recently submitted report of Mr. R. P. Miller, Chief Engineer, Bureau of Buildings, New York City, for the year 1904. The report is in abstract as follows:

Primarily the engineering force exists for the examination of plans and specifications for new buildings and alterations. The number of such applications is given in the statement of the Plan Clerk as 4,121, representing an estimated value of about $84,000,000.

During the spring and early part of the year the applications are more numerous than in the latter part, so that for part of that time four assistant engineers and one inspector are steadily engaged on this work. When this work falls off one or two of these men are engaged in outside inspections and examinations, so that the work is done on an average by four men, or about 1,000 applications to each man. When it is remembered that these applications are amended from time to time for various reasons, averaging two times for each application, the amount of work done will become evident.

Next in importance to plan examinations is the work done in connection with the supervision of tests of new materials and construction. During the year just closed, the following tests have been made under the supervision of this bureau: Ten fire and water tests, conducted according to the requirements of Section 106 of the Building Code, were made on various forms of fireproof floors; eleven load tests were made, of which nine were on modified forms of constructions already approved, and two on floors in buildings in course of erection, where some doubt as to their strength or construction existed. Of these 21 tests, five fire tests resulted in failure, five fire tests were successful, eight load tests established the working loads for the types under consideration, and the other three proved the safety of the constructions for assumed working loads. As a result of tests, approvals for twelve new types were issued.

Considering the tests in more detail: Four of the fire tests were on concrete-steel construction, in which a 1:2:4 stone concrete, reinforced by steel bars of various shapes, was used for not only the floor constructions, but also for the girders and columns, and which come under the Concrete-Steel Regulations issued by this bureau in 1903. Two of these tests resulted in failure. The other six tests were on floor fillings between steel beams. One of the successful constructions consisted of reinforced stone-concrete lintels resting on the lower flanges of the steel I-beams. Two long span tests were made on stone concrete slab constructions, reinforced with expanded metal, one being successful, the other, not. Two cinder concrete constructions were tested, only one of which was successful. Finally a terra cotta floor construction was tested, resulting in failure.

Eight cinder concrete floor fillings were tested to destruction by loading, all being on modified forms of constructions already approved. These tests were made to establish the working loads to be used for those particular types, such load being one-tenth of the load at which the construction failed in each case. A similar load test was also made on a 25-ft. span of Guastavino arch construction, the test not being carried to destruction as the abutments began to yield before there was any sign of failure in the arch. The remaining two tests were made in buildings in course of construction, to establish their ability to safely carry the loads for which they were designed. One was on a segmental terra cotta arch; the other on a cinder concrete slab. In both cases the safety of the constructions was established.

During the year, seven fire tests have been made, under the supervision of this bureau, on fireproof partitions. As a result of these tests, approvals were issued for five forms of construction.

Other tests, in connection with the work of the bureau, were as follows: Tests on new materials of construction, as provided for in Section 20 of the Building Code, were made on sand-lime brick and artificial stone, and included compression, transverse, absorption, freezing and fire tests. The results were only partially satisfactory, and have raised the question whether the standard fixed by this bureau is not too high. An investigation into this matter is now under way, and it is hoped that as soon as the experiments, now being made, are completed, the matter will be definitely settled. A report may be expected early next year.

Numerous solutions and paints for the fireproofing of fabrics, scenery and woodwork on theater stages were submitted to this bureau for test during the year. All of the samples submitted made a good showing, but no approvals were issued inasmuch as results in actual practice cannot be judged from samples. Acceptance of the treatment depends on tests made on the materials in each individual case, and a certificate is issued where the following specifications of this bureau are met:

In the case of fabrics, scenery and the wood frames for the same, there must be no flame or glow after the application for fifteen seconds of the flame of an ordinary alcohol lamp or torch.

In the case of so-called fireproof paints, the following regulations have been adopted:

(1) The term "fireproof paint" shall be understood to mean any preparation used to cover the surfaces of wood or other materials, for the purpose of protecting the same against ignition.

(2) No fireproof paint will be considered satisfactory unless it so protects the wood or other material to which it is applied, that the same will not flame or glow after having been subjected to the flame of a gasoline torch for two minutes.

(3) Before applying fireproof paint to any material the surfaces must be cleaned.

(4) Application of fireproof paint must be repeated whenever it is found that the material to which it is applied is no longer protected to fulfil Specification No. 2.

Fireproofing solutions and fireproof paints, which have been tested or are being used in this borough, meeting the above requirements satisfactorily, are made by the following concerns: Antipyros Klugiana, 487 Broadway; Blenio Fireproofing Co., 345 West 22d St.; Electric Fireproofing Co., 327 Ave. B; Fireproofine Co., 88 Beaver St.; Frank Ring, 3 West 132d St.; Gordon Fireproofing Co., 447 Harrison Ave., Boston, Mass.; Maas Fireproofing Co., 717 East 140th St.; Reliance Fireproofing Co., 280 Broadway.

Any treatment, however, that will render the material sufficiently fire-resisting to meet the above requirements will be accepted.

No new incombustible materials to be used for flooring or interior trim in buildings over 150 ft. high (Section 105 of the Building Code) were submitted for approval this year. The materials thus far approved for this purpose are: Alignum, 330 East 98th St.; asbestolith, 156 Fifth Ave.; chalmanus, 405 West 14th St.; lignolith, 118 North 11th St., Brooklyn; magnesia building lumber, 115 William St.; taylorite, 156 Fifth Ave.

Cement tests, as provided for in Section 16 of the Building Code, have also been made from time to time, and the reports have been placed on file. Tests for determining the carrying capacity of piles, as called for in Section 25 of the Building Code, have been made, in two cases the piles under test being of concrete-steel.

In addition to the work outlined above, the engineers have been called on in special cases to make inspections and investigations in other matters, as shown below: Unsafe building cases, 16; violation cases, 24; fire escapes and means of egress, 5; occupancy of premises, 9; theaters, 240; soil and foundations, 105; general condition of building or wall thicknesses, 56; progress of work, 174.

WATERPROOFING CONCRETE STRUCTURES.*

By W. H. Finley,† M. Am. Soc. C. E.

Ever since concrete has entered so largely into the field of construction as a substitute for stone masonry there has been more or less discussion as to its permeability, and various expedients have been resorted to to prevent the seepage of water through the material. This refers more particularly to the large masses of concrete built for engineering structures. I am aware that there has been more or less success in making concrete impervious to water by various means, but do not think that any of them have given such satisfaction as to become generally used.

It is a question whether the addition of alum, soap and other extraneous material does not affect the lasting qualities of the concrete. If the announcement of the "Star-Stettin" Portland Cement Works that they are now manufacturing, according to a process invented in Germany, a waterproof cement which will become impervious to water, will resist the action of frost, heat, hot water, sea water and diluted acids, is borne out, the question of waterproofing concrete is settled for all time. However, concrete, as usually built in many engineering structures, is not impermeable, and some method of waterproofing the same, I think, is vitally necessary. That this is appreciated by engineers is clearly evidenced by the amount of waterproofing that is now being done on concrete arches, abutments, retaining walls, etc.

I have for years recommended the necessity of waterproofing both stone masonry and concrete structures where there was any danger of seepage of water, and believe that such a precaution will extend the life of the structure. A recent examination of concrete abutments, retaining walls, etc., built in Chicago some years ago, disclosed the fact that water was seeping through the mass in several places, particularly along the parting planes where the work was not carried on continuously. This condition is frequently observed in concrete construction, and could be entirely prevented if the back of the structure were thoroughly waterproofed with asphalt.

Some years ago I had occasion to repair some masonry arches built in 1862 that were rapidly disintegrating owing to the infiltration of water. These arches were uncovered, the damaged stone replaced, and the extradosal surfaces of the arches were plastered with cement concrete and then thoroughly waterproofed with asphalt. Time has demonstrated that this work was very successful. I have since uncovered a number of arches that were leaking and found that the concrete backing did not prevent the entrance of water. These were cleaned off and waterproofed with asphalt in each case. It is now the practice on a number of railways thoroughly to waterproof all arches, abutments, retaining walls, etc. The method generally employed is to use as a first coat asphalt cut with naphtha, to be applied as a paint to the concrete after the same is perfectly dry, and then cover the surface with an asphaltic mastic composed of 1 part of asphalt to 4 of sand; this to be smoothed off with hot smoothing irons and thoroughly tamped and pressed into place. If the filling over the arch is ordinary gravel or dirt no other work will be necessary, but if it is filled with broken stone or stone chips it is better to cover the surface of the asphalt with washed roofing gravel so that

*Abstract of a paper read at the meeting of the Cement Users' Association, at Indianapolis, Jan. 17, 19, 1905.

†Late Principal Assistant Engineer, Chicago & Northwestern Ry.

the broken stone will not cut or damage the asphalt surface. There are various other methods employed in waterproofing concrete surfaces with asphalt, such as the use of burlap or other fabric imbedded in the asphalt coating. It is very difficult to make hot asphalt adhere to a concrete surface however dry the same may be, unless it is heated by artificial means. Hot asphalt laid on ordinary dry concrete will not adhere and can be rolled up like a blanket after it has cooled. The writer has had some success in applying hot asphalt direct to concrete surfaces after the same had been dried and heated with hot sand, but much prefers the use of the asphalt cut with naphtha applied as a painting or swabbing coat. The cost of this work with present prices of first-class asphalt will range from 10 to 20 cts. per sq. ft., depending upon local conditions. It does not require any special expert knowledge for its application. After a brief coaching the forces usually employed can produce a satisfactory job.

It might be well to say something about the quality of the asphalt to be used for waterproofing purposes. In the past few years there has been a large development of asphalt for this purpose and it is now possible to get, at a reasonable price, a pure asphalt that will not flow under a temperature of 212°, and not become brittle, when spread thin on glass, at 15° below zero. Also it will resist the action of acids and alkalies.

The following specification is one that I have used with good results in waterproofing works:

MATERIAL.—Asphalt shall be used which is of the best grade, free from coal tar or any of its products, and which will not volatilize more than ½ of 1% under a temperature of 300° F. for 10 hours.

It must not be affected by a 20% solution of ammonia, a 35% solution of hydrochloric acid, a 25% solution of sulphuric acid, nor by a saturated solution of sodium chloride.

RANGE OF TEMPERATURE.—For metallic structures exposed to the direct rays of the sun, the asphalt should not flow under 212° F. and should not become brittle at 15° F. below 0° when spread thin on glass.

For structures underground, such as masonry arches, abutments, retaining walls, foundation walls of buildings, subways, etc., a flow point of 185° F. and a brittle point of 0° F. will be required.

The asphalt covering must not perceptibly indent, when at a temperature of 130° F. under a load at the rate of 15 lbs. per sq. in.; and it must remain ductile at a temperature of 15° F. below zero on metal structures, and at 0° F. on masonry structures under ground.

PREPARING SURFACE.—Before applying asphalt to a metal surface, it is imperative that the metal be cleaned of all rust, loose scale and dirt; and if previously coated with oil, this must be burned off with benzine or by other suitable means. The metal surface must be warm to cause the asphalt to stick to it, and the warming is best accomplished by covering it with heated sand, which should be swept back as the hot asphalt is applied.

When waterproofing masonry structures, if the surface cannot be made dry and warm, it should be first coated with an asphalt paint made of asphalt reduced with naphtha. This is particularly necessary for vertical surfaces.

PREPARING ASPHALT.—The asphalt should be heated in a suitable kettle to a temperature not exceeding 450° F. If this is exceeded it may result in "pitching" the asphalt. Before the "pitching" point is reached, the vapor from the kettle is of a bluish tinge which changes to a yellowish tinge after the danger point is passed. If this occurs, the material should be tempered by the addition of fresh asphalt. The asphalt has been cooked sufficiently when a piece of wood can be put in and withdrawn without the asphalt clinging to it.

APPLICATION OF ASPHALT TO METAL SURFACES.—The first coat should consist of a thin layer poured from buckets on the prepared surface and thoroughly mopped over.

The second coat should consist of a mixture of clean sand or screenings, free from earthy admixtures of clean sand or screenings, free from earthy admixtures, previously heated and dried, and asphalt, in the proportion of 1 of asphalt to 3 or 4 of sand or screenings by volume; this is to be thoroughly mixed in the kettle and then spread out on the surface with warm smoothing irons, such as are used in laying asphalt streets.

The finishing coat should consist of pure hot asphalt spread thinly and evenly over the entire surface, and then sprinkled with washed roofing gravel, torpedo sand, or stone screenings, to harden the top.

The thickness of the coating will depend on the character of the work and may vary from ¾-in. to 2 ins. in thickness.

GENERAL.—Where a quantity of asphaltic concrete is required, such as in trough floors on bridges, a concrete should be made in the proportion of 1 part asphalt, 2 parts sand and 3 parts limestone screenings, thoroughly mixed and rammed into place with tamping irons on the first coat of pure asphalt with which the metal was originally covered. At all drainage holes large sized stone should be carefully placed by hand to insure perfect drainage.

It may not be out of place in discussing the question of waterproofing, to call attention to the necessity for provisions for drainage in all concrete and masonry structures. This has not been given as much attention as it should receive. Whether waterproofing material is applied or not, the question of thoroughly draining the structure is of the greatest importance.

In ordinary building construction sufficient attention has not been given by architects and builders to the proper waterproofing of their foundation walls. I have observed recently in this vicinity a number of buildings in process of construction where the excavation for the cellar and lower foundations were made in a clayey material and concrete foundation walls put in without making any attempt to apply a waterproofing or damp-proof coating to the wall or provide suitable drainage to carry off the ground water. In this particular we are falling away behind even the early Roman architects and builders. In all the examples of their work it is evident they gave the greatest consideration in their construction to proper methods for keeping their foundation walls dry, and we cannot do better to-day in such matters than follow the advice of the great architect Vitruvius who, writing about 25 years B. C., described methods of waterproofing and ventilating foundation walls that compare favorably with the best methods used to-day, excepting that we may have better materials for waterproofing than were known at that time.

Asphalt makes the best damp-proof or waterproofing material that can be used in foundation walls and for all structures where such provision is necessary. It has been used from the earliest times for the purpose of protecting material from air and water and we have examples of it in our museums where the mummy cases were sealed with this material more than 3,000 years ago.

The various makes of hollow concrete block offer a good field for the application of waterproofing. It is in line with the ideas of the early Romans in building hollow walls to take care of the question of dampness. These blocks laid up in asphalt, and with the surface next to the ground thoroughly coated with the same material, make an ideal damp-proof wall.

I have found that the waterproofing qualities of asphalt, even when used under water pressure, is all that could be desired. When repairing a stone reservoir recently the following method was used: A single course of brick was laid up in front of the wall, this brick being heated until the moisture was driven out, and then soaked in hot asphalt and laid in place, the space between the brick and the stone being filled with an asphaltic concrete of limestone, screenings and asphalt in the proportion of about 1 to 4. These brick were anchored into the stone wall at intervals and the work has given very good satisfaction.

STREET RAILWAY INVESTMENTS IN MASSACHUSETTS UNPROFITABLE.*

The street railway returns of the year are suggestive. Of 74 companies operating 2,654 miles of main track, 30 failed to earn expenses and fixed charges; 25 paid dividends; of the 25 which paid dividends 14 earned them during the year. Five companies, as stated above, have been in the hands of receivers.

Very few companies beside keeping their railways in good repair reserved for depreciation what prudent management would require. Generally present necessities only have been met, the future with its inevitable expense of replacement and reconstruction being allowed to look out for itself.

Under chapter 483 of the Acts of 1902 the Board annually prepares a yearly list of companies which appear from their returns to have properly earned and paid a dividend of at least 5% for the five years immediately preceding. Thirteen companies were found to be entitled to a place upon the list submitted in January, 1903; the list of January, 1904, contained the names of twelve companies; that submitted this year contains the names of ten companies.

Our attention has been repeatedly called to the unusual expenses consequent upon the severity of last winter's weather and to the loss of receipts in the summer owing to the coolness of the season. But it is not safe to count upon mild winters and warm summers in this part of the country, and while it is agreed that the past year was an extraordinary one, it is plain that the weather did not drive five companies into insolvency and others perilously near it. The evil is more radical.

In the early days of the change from horse to electric railway, promotion ran wild with the idea that immense profits were to be realized in the extension of the old and in the construction of new railways as electric roads in any and every direction; that where no business was in sight, it would appear under the creative magic of the electric car.

The test of this opinion, necessarily a test of years in which novelty disappears, is now practically complete. Experience has shown that with the more expensive roadbed and equipment, the heavier rail and larger cars, there has not been the corresponding and expected development of permanent business. Operating cost, too, in heating cars and in repair and renewal of plant, has proved larger than was expected. With the new accommodation and the nearer approach to railroad conditions has come the increased demand of the public for expenditures in the interest of safety and comfort which had not been counted upon, as for example, in construction of double track, installment of signal systems and establishment of waiting rooms.

Hurried along by the natural enthusiasm for the new type of railway with its many most attractive features, capital, sometimes deliberately misled, has been invested in undertakings for which there was no sufficient demand and which are now represented by roads run, not only without return upon the investment, but at an actual loss of capital. In such cases the future promises as possible events: the acceptance of an unsatisfactory service as better than nothing; an increase in fares; or the abandonment of the railway.

It is a source of gratification that under our restrictive laws, while capital has taken its own risk as to the earning capacity of these enterprises, in no case has there been an issue of stock or bonds in excess of the fair value of the railway property, to act as a contributing factor to the existing troubles.

Upon some railways fares have been raised, and with encouraging results, but this action is usually unpopular and is often taken at the risk of lessening the volume of business. It is, moreover, at times complicated by arrangements made between companies and town officials that locations and privileges in the streets were granted; this, however, this is the remedy, it is better that it be applied than that the public lose the benefits which the railway may bring.

*From Advance Sheets of the 36th Annual Report of the Massachusetts Board of Railroad Commissioners.

THE MANUFACTURE OF CONCRETE FENCE POSTS.

By J. A. Mitchell.†

The scarcity of timber suitable for fence posts has brought the question of using concrete posts to the front and it has been demonstrated in a number of localities that concrete fence posts are a success, when properly constructed. I have seen posts that have been in the ground for over ten years, and they were better than when first set. I have never known a post to be broken after it was once set in the line of fence.

I have used both the dry and the wet or slush mixture in the manufacture of posts, and have obtained good results from both; but I have made the neatest and the best posts with the dry mixture, although it is a much slower process. As to the proportion of cement and sand, one must be governed by the quality of sand used. I have used 1 to 3, 1 to 4, and even 1 to 5 with varying results. There is such a thing as making a mixture too strong in cement. I tried 1 sand to 1 cement, and the posts made in that way were an entire failure, from some cause that I could not account for.

It is next to impossible to make a post without some sort of reinforcement. Wood has been tried, but it positively will not do. Metal is the only practical reinforcement. Galvanized metal should be used, and round in shape. It is very hard to get a good post when flat metal is used. Corrugated rods are very good.

Fastenings for attaching the fence to posts have puzzled the manufacturer. Holes through the post were the first device for fastening the fence, but there are two objections to the use of holes. One is, that the holes weaken the post, and the other is it takes too long to make them. Eyes made of wire, hooks and staples imbedded in the concrete have been tried for fasteners, but the best fastener is the one that fastens the fence and post firmly and rigidly together.

Wooden molds are the best. They are light, easily and cheaply made, and last a long time if kept under cover. The double mold, for two posts, is best, and the mold should be collapsible, so that the posts can be removed from mold in from 24 to 48 hours after making. Molds that have been in use for three years are good yet. Molds cannot safely be removed from the post until the concrete is set. The shape of post renders it liable to crack if handled before the cement sets. Iron molds are too heavy to handle and too expensive.

Posts can be manufactured at a cost of from 11 to 12½ cts. each, counting cement at $1.50 per barrel, gravel at 40 cts. per yd., metal at 2¾ cts. per lb., and labor at $1.50 per day. Two men will make 100 posts per day, while three good men can make 175 to 200 per day. The more men that are used working together, the less the cost per post for labor.

It has been a question with some persons as to whether a cement post would stand freezing weather. I have put the posts to all kinds of tests, and exposed them in every way to all kinds of weather. I have set them in the ground where the water would stand in a wet time, and have had it freeze to a depth of 2 ft. or more where this water stood without affecting the post in the least. I have cut the ice off of the top of a pile of posts that I wanted to ship, and found them in the best condition. The cold weather has no effect on them whatever, neither does the heat. I burned some pieces of a broken post in my stove last winter all winter, using them for a fire brick, and they were as good in the spring as they were when put in the stove. One great advantage of cement over the wood post is that there is no danger of burning the post if the fence row burns out, as is so often the case along railways.

After an experience of over three years in the manufacture of cement posts, I know they are a success, and can be manufactured and sold at a good profit and at a price lower than is asked for a good wood post. I have had no trouble in selling all the posts that I could get made, and at a good price, retailing them at 30 and 35 cts. for the small or line posts, and $3 each for the end and corner posts.

*Abstract of a paper read before the Association of Cement Users, at Indianapolis, Ind.

†Goshen, Ind.

A FIVE-STAGE AIR COMPRESSOR has recently been built in England by Peter Brotherhood, the inventor of the Brotherhood engine. The machine is of the vertical type, and has a capacity of 10,000 cu. ft. of free air per hour compressed to 3,000 lbs. per sq. in., when run at a speed of 120 r. p. m.

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The remarkable financial results of Massachusetts street railways, as reported by the State Railroad Commission, ought to exert a much-needed conservative influence in checking extravagance in the promotion of electric railway schemes. It used to be thought by railway officers and by financiers who were not of the "frenzied" order that before building a railway it was well to inquire whether there was likely to be traffic enough to make it a paying enterprise after it was completed.

All such counsels of conservatism have been pooh-poohed by electric railway builders in recent years. They have declared that if a road were once built, it would create traffic enough to make it pay, and they have labored industriously to have this idea accepted by the investing public. As a result a good many hundreds of miles of electric railways have been built which are bound to be a losing venture for those who furnished the money to build them.

This is a sort of "Frenzied Finance" which deserves emphatic condemnation. In a large number of cases, we believe, the promoters who built these roads and the bankers who sold the securities were shrewd enough to know that the enterprise was at best a doubtful one; but their only interest was to make a profit from the construction and equipment of the road and the sale of its bonds. Whether the road could earn the interest on its cost after completion or not was a matter for which they cared comparatively little.

If these are deemed too harsh strictures, let the actual results of operation of Massachusetts electric railway companies speak for themselves. Out of 74 operating street railway companies in Massachusetts, there are only 10 which, according to the State Railroad Commission, have properly earned and paid a dividend of at least 5% for the past five years.

This is the financial result of electric railway construction in Massachusetts, where population is on the whole more dense than in any other state of the Union and where over-capitalization and stock-watering are held in check as they are nowhere else in the United States.

If such results obtain in such a state as Massachusetts, what after-harvest shall we reap from the electric lines with which Ohio, Indiana and Illinois have been gridironed during the past few years? A number of electric roads in these states have already met financial disaster, and the number is certain to be increased as the roads grow older and heavy expenditures become necessary for maintenance and renewals of rolling stock and permanent way.

We call attention to the above facts, it need hardly be said, not in any spirit of criticism of electric railways per se. No doubt whatever exists that for the operation of street railways and for certain classes of suburban railways electric traction is so far in advance of all other systems that nothing else is to be considered. What we have condemned in the past, and as events have shown with good reason, is the construction of electric railways which were manifestly "built to sell," and which were little better than a fraud on the investing public. That public is now rapidly learning that there is no magic in the electric motor to create something out of nothing, either mechanically or financially, and that with electric railways as with steam railways, great expectations of future traffic are a poor foundation on which to issue bonds.

We published last week President Roosevelt's special message to Congress in which he urged new legislation with respect to the Panama Canal Commission on the following grounds:

> So that the President, who is charged with the responsibility of building the canal, may exercise greater discretion in the organization of the personnel through whom he is to discharge this duty, as actual experience has convinced me that it will be impossible to obtain the best and most effective service under the limitations prescribed by law.

Just what organization the President would substitute for the present Commission is not very clear, but apparently what he has in mind is a Board of Consulting Engineers who shall have no executive duties, and, a Commission of three to five members, charged with executive duties only, "whose respective duties, powers and salaries should be assigned to them by the President" and who, we judge, would probably not be engineers.

An idea somewhat similar is expressed by Secretary Taft in transmitting to Congress the annual report of the Canal Commission (printed elsewhere in this issue). We quote as follows:

> Without criticising the Commission, which I think has made as much progress in the necessary preparation for the building of the canal as could be expected in the short time since its appointment, it is not improper for me to say that under the present law the plan for building the canal is unelastic. The evident purpose of the act to require the President to act through the Commission as a body and not to distribute work and responsibility to the members severally, and to fix the salaries of the individual members according to the work which they are to do, renders the instruments with which the President is to build the canal less flexible than they ought to be. If he were able to designate of the Commission certain members to have charge of the executive work, and others to act as consulting engineers in an advisory capacity, and other members of the Commission to discharge other necessary functions, he could construct a machine in the form which experience might indicate to be the most useful.

With Congress in its present temper toward the existing Canal Commission and the Executive urging abolition or reorganization, a radical change in that body would appear almost inevitable. Yet as was set forth in this place two weeks ago, no sufficient reason has appeared why the existing law should be altered. This law now reads that the members of "the Commission shall in all matters be subject to the direction and control of the President." It also empowers the President to fix their salaries, unless Congress itself shall later do this, and he is expressly authorized to remove a Commissioner from office at any time.

Why the President should need any different or broader powers over the Commission, it is difficult to see. If he desires to assign specific work to one Commissioner or to another and to fix differing salaries for different members, as appears to be his desire, he has already that power. If he is dissatisfied with the personnel of the Commission and thinks he could improve on his original selection, the power is already in his hands to make any changes. If he desires the Commission to make their headquarters on the Isthmus and devote their entire time to the work, that too is clearly within his powers to require.

Why then should Congress be asked to tinker with the law? There is much danger, it seems to us, that the result of any tinkering may be for the worse and not for the better. The present law has the invaluable feature of requiring at least four of the seven Commissioners to be "persons learned and skilled in the science of engineering." We should regard any change in this provision and any change in the plan of carrying out the work through a Commission as a most serious detriment to the canal enterprise. As we have repeatedly pointed out, many of the greatest public works in this country, state, national and municipal, have been carried out by Commissions, and in every case where the work has been of such magnitude that the Commissioners were selected for reputation and ability and not to serve political ends, the results have been in the highest degree satisfactory.

How many kinds of engineering are there which have distinct names? We pass the question along to any of our readers who may happen to have sufficient spare time and curiosity to investigate it. Meanwhile we notice in the catalogue of an engineering school, recently received, that it boasts a "professor of refrigerating engineering" and a "professor of thermal engineering." If we translate the words of classic origin to our mother tongue, we have "cooling engineering" and "heating engineering." As these two professors' names are placed in juxtaposition in the catalogue, one is led to speculate on the chances of their neutralizing each other!

We call attention to this, not in criticism but to record the rapid tendency toward the development of special branches of engineering to which special names are given. "Thermal engineering" is an entirely new coinage, so far as we recall; but "heating and ventilating engineers" have long been associated in a national society; while an "American Society of Refrigerating Engineers" has recently been organized.

The institution above referred to also boasts of a professor—and a very well posted professor, too—of "Aerodynamics," and we wonder why it was not called "aerodynamic engineering." The unschooled—or partially schooled—person might guess that this related to flying machines; but he would guess wrongly, for from the professor's name we know that "aerodynamics" actually refers to the much more prosaic art of moving air by means of fans. Again we are tempted to suggest a translation of the Greek; although we must confess that no one would want to be called a professor of "blowing engineering." Besides it may be objected that the "aerodynamics" referred to relates also to machines which tend to produce a vacuum, and a "sucking engineer" or even an "exhausting engineer" would be even worse!

IS DAY LABOR CHEAPER THAN CONTRACT WORK?

Periodically the statement reappears in the transactions of engineering societies, or elsewhere, that the day-labor method of construction has been demonstrated to be more economical than the contract method in some particular case, and the inference is drawn that no good reason exists why the day-labor method should not be preferred in all cases.

In our issue of Jan. 12 an abstract was given of a paper by Mr. W. A. Shaw, Assistant Engineer of Intercepting Sewers (Chicago), from which it appears that a sewer was built by day labor at less cost than the bids received for the same sewer. At the close of the paper Mr. Shaw says:

> It has been clearly demonstrated that the city of Chicago can do its own work cheaper and more advantageously by day labor than by contract.

This is a rather broad generalization to found on one particular case. It illustrates a common and erroneous method of reasoning, for it assumes that what is true of one will be true of all. Moreover, as sewer constructors should know, there are few classes of work more hazardous, particularly under the common form of specifications which attempt to make the contractor stand all unforeseen expenses. A few hundred feet of trench in quicksand, one accident in which a number of men are buried by a cave-in, or an unexpected amount

of boulders to be removed, may wipe out all profits and cause a substantial loss. Sewer contractors have been known to make a small fortune on one job, only to lose it on the next. Of all classes of work, in none is it more illogical than in sewer work to generalize from one example.

Looking upon contract work in a broader way, it will strike the thinking man as having substantial justification for its existence, by the fact that it does exist. Engineers on railways and on public works have repeatedly tried to save contractors' profits by resort to the day-labor method—often with success for a time, but, in the end, a return to the contract method has proved more profitable. Why is it that the managers of coal mines prefer to mine coal by contract? Why do manufacturers find piece work (which is contract work under another name) preferable to day work? Why are county roads built at less cost by contract than by working out the poll tax? Why, in the face of the fact that they have an organization for day work, do railroads contract for their heaviest work? Men of intelligence and keen desire to save every dollar of cost can hardly have adopted the contract system without having tested it in comparison with the day-labor system. These tests have been so varied in character, and have extended over so many years, that we are driven to conclude that in the long run, with men constituted as they now are, it pays to do most classes of work under some form of the contract system.

Still it will be argued that there are exceptions to this rule, as to others—the Chicago sewer in point. Let us consider, however, whether or not some of these so-called exceptions are entitled to the weight given to them. When an engineer has drawn specifications and plans for a given piece of work, and, after rejecting all bids, undertakes to handle the work by day labor, he has a most powerful incentive to do the work at less than the lowest bid—or at least to show records of unit cost indicating that he has done so. Acting under this natural incentive, and being his own inspector, he is likely to change both plans and specifications wherever and whenever he sees an opportunity to decrease the cost by doing so. This, it may be urged, is all for the good of the structure; but sight should not be lost of the fact that under a contract no changes in the specifications and few in the plans would be made even to save the contractor from a great loss than might easily be prevented by a slight change. We have in mind a good example of holding a contractor to his contract. On some water pipe work, rock was encountered in the bottom of the trench for several hundred feet. By raising the grade of the pipe 2 or 3 ins., nearly all the rock excavation could have been avoided. Was the grade raised? No, indeed. The contractor should have foreseen what the engineer had not foreseen, for it was the contractor's province to anticipate all obstacles and make due allowance for them. On the other hand, had the same engineer been doing the work by day labor, who can doubt that the grade would have been raised?

An engineer who has had charge of the construction of many important sewer systems always provides a special price for the payment on any quicksand that may be encountered, and he tells us that in this way he secures far lower unit prices on trench excavation. How many specifications contain such a provision? Is it fair to compare day-labor casts on one job with contract prices on work where the contractor is compelled to insure himself by high bidding against every contingency, including errors in the engineer's bidding sheet and plans?

Turning to another phase of this subject, how often do engineers submit their itemized estimates of cost together with the subsequent actual costs by day labor? We know of more than one instance where engineers have published seemingly low unit costs which, upon inquiry, were found to contain no allowance for cost of plant or for engineering superintendence of the work. Extremely low records of dredging costs have been published, but in nearly every case no record is given of the actual cost of repairs and maintenance. When an allowance is made for interest on the investment in plant it is usually based on the erroneous assumption of years of continuous work for the plant. Often the cost of moving the dredging plant from place to place is omitted, and we have merely the labor and fuel costs while the dredge is actually at work. Then again the cost of experimental work with new machinery or new men is apt not to be published, but records are given of the costs after the work has been thoroughly organized—which often means just about the time the job is finished.

Often a home-made plant is used, and the low first cost of the plant is compared with the high first cost of a similar plant purchased from manufacturers. But we hear nothing of the cost of operation due to delays from breakdowns or due to insufficient capacity.

The salvage value of falsework, sheeting, sheds, old plant, etc., is commonly over-estimated; sometimes no allowance at all is made for depreciation. Thus, in a word, the very examples used to prove the advantage of day-labor work often prove the contrary when complete records are secured.

There appear to be two general conditions under which it may be claimed with reason that the day-labor system is to be preferred to the contract system, namely, (1) when there is extreme uncertainty as to kind and quantity of the various items of work that will need to be done, and (2) when there is great difficulty in inspecting and measuring the work done. This last condition is well exemplified in such work as track maintenance, street cleaning and maintenance, and the like. The first condition is exemplified in difficult tunnel work, where the character of the materials to be encountered cannot be predicted. To these two conditions a third might be added, namely, the absence of true competition among the bidders. This is a condition, however, that can usually be done away with by drawing specifications upon which the author of the specifications himself would be willing to risk his money were his worst enemy the inspector. Then outside competition can usually be secured, if a complete subsurface survey has been made to show the quality of the proposed excavation.

If one wishes to prove by one or more examples that contractor's bids are higher than day-labor costs, let him proceed as follows: (1) Make no effort to ascertain subsurface conditions, but require the contractor to assume the risks of encountering quicksand, rock or what not; (2) Make the engineer (the hired expert of the party of the first part) the court of final resort in case of any dispute between the party of the second part and the engineer; (3) Make the party of the second part the servant of the party of the first part, but require this servant to assume all risks for damage by floods, by accidents of every kind, by delays due to failure of public funds to complete the work, by strikes, by errors in plans or estimates, by changes of grades or alinement, by peremptory discharge of foremen, by failure to comply with every order of the engineer relating to time, place, force and method of attack, and by such other conditions as the combined ingenuity of a lawyer and an engineer can devise. The result will be a standard set of specifications warranted, at times when other work is plentiful, to scare away outside contractors entirely and stimulate the few local firms to "combine to put up prices."

LETTERS TO THE EDITOR.

A Call for an Engineering Society in West Virginia.

Sir: It is my desire to form an organization of all the engineers in southern West Virginia and the neighboring borders of Kentucky and Ohio, for the purpose of mutual advancement and interchange of thought. I have no definite plan as to the form of the organization, but I would be glad to have every engineer in this field who sees this write me his ideas on the subject.

Respectfully, Henry Mace Payne,
Civil and Consulting Engineer.

White Building, Williamson, W. Va., Jan. 21, 1905.

A Heavy Hammer Desirable for Driving Concrete Piles.

Sir: In your issue of Jan. 5, a note concerning the building and driving of concrete piles abroad was especially interesting. It is the first time I have seen any endeavor made to use a pile driver hammer of proper weight for such work. The formula quoted, according to w[hich] the supporting power was computed, also is along right track.

In driving any pile (timber, steel or concrete), a ha[m]mer of weight from one or two times that of the piles sh[ould] be used; the larger the better, up to about that r[atio]. When a hammer of large ratio of weight to that of [pile] is used, a proper formula must take some account of [the] ratio, as one of Weisbach's formulas does, like [Ma]son's and several others.

As far as known in this country, too light ham[mers] have been used. This was forcibly called to the w[riter's] attention nearly two years ago, when he was invited to witness the test driving of one of the first concrete [piles] in the City of New York. Since that date many imp[rove]ments have been instituted, but, so far as known to [the] writer, no one has made use of a hammer of econo[mical] weight.

Yours truly,
E. P. Goodrich,
Chief Engineer, Bush Terminal Co.

Coffee Exchange Bldg., New York, Jan. 15, 1905.

The New York Subway not a Good Argument for Lump Sum Bidding.

Sir: I read with interest your editorial on "Lump Sum versus Unit Price Bidding" in your issue of Jan. 5. While I do not in the least desire to question the completeness of the estimates presented to the bidders on the first subway work, recently successfully completed, it is not yet known what the extras will amount to on this work. As a matter of fact, the subway work affords no adequate argument in favor of lump sum bidding, as the importance of the 50-year operation franchise, with a privilege of renewal for a similar period, far outweighs the question, "Can the work be done at the engineer's estimates?" If this work actually cost the contractor double the amount he received for it, it would still undoubtedly have been a profitable investment. In support of this opinion it will be remembered that when bids were called for the first extension to the original subway work, including the tunneling of the East River, the lowest and successful bidder agreed to do the work for about one-third of the engineer's estimate, undoubtedly proving the importance attached to the franchise feature.

It is to be hoped that in the case of the rapid transit work some way can be devised whereby we can have an opportunity of learning the relation between the original lump sum bid and the final amount that would have been paid to the contractors had the franchise feature been eliminated. This can in a measure be determined by the extras paid to the sub-contractors, and it is to be hoped that this amount will be made public.

While as a general principle your statement that "had the surveys been less thorough, or the study of the problems made in haste, no lump sum bidding would have saved the day" is true, it does not necessarily apply under the peculiar conditions surrounding the letting of the subway work.

Yours truly,
Alexander Potter.

143 Liberty St., New York City, Jan. 9, 1905.

More Information about the Volume of a Perch.

Sir: Enclosed please find letter from the Department of Commerce and Labor, Bureau of Standards, that might interest your readers.

Yours respectfully,
Kissick & Mooney.

4138 Market St., Philadelphia, Jan. 21, 1905.

Mr. Thomas J. Mooney, Philadelphia, Pa.

Dear Sir: Referring to yours of the 3d inst., which we could not answer until certain information had been secured, I have to say that there is no recognized official perch of masonry. In Oklahoma, North Dakota, South Dakota and Ohio, it is fixed at 25 cu. ft. of stone. In Delaware it is 24¾ cu. ft. in walls, 27 cu. ft. when piled on the ground, 30 cu. ft. when in a boat, and 30½ cu. ft. in cars. In Colorado a perch of stone in mason work is 16½ cu. ft., and for brick-work measure laid in a wall, 22 bricks per cu. ft. for a foot wall and 15 bricks for what is known as an 8-in. wall. We are informed that in Philadelphia 22 cu. ft. is considered a perch, but we have no authority for this statement.

Trusting that the above information may be of some service to you, I beg to remain,

Respectfully,
S. W. Stratton,
Director.

Department of Commerce and Labor,
Bureau of Standards, Washington,
Jan. 19, 1905.

Sir: Is not your correspondent in your issue of Jan. 12 justified in assuming the cubic contents of a perch to be 24.75 cu. ft.? I find that four reliable handbooks define a perch of masonry as 16.5 ft. × 1.5 ft. × 1 ft., or 24.75 cu. ft., and, quoting from Trautwine:

A perch of masonry actually contains 24¾ cu. ft., being 16½ × 1½ × 1 ft. It is generally taken at 25 cu. ft., but by some at 22 cu. ft., etc., and there is every probability that a payer will be cheated unless the number of cu. ft. be distinctly agreed upon in the contract.

The fact, however, that most tables of measures refer to a perch as 24¾ cu. ft. would lead to the belief that such

is the general accepted standard. Is there any record of the actual measurement upon which the claim for 22 cu. is based? Yours truly,

O. H. Fogg.

Flushing, N. Y., Jan. 14, 1905.

(Mr. Walt's "Engineering and Architectural Jurisprudence," pages 548 and 557, a number of cases are cited of suits arising out of the meaning of the word perch.—Ed.)

Wind Stresses in Knee-Braced Mill Buildings.

Sir: Referring to my communication on "Wind Stresses in Knee-Braced Mill Buildings," as published in Engineering News of Oct. 6, 1904, I desire to remark that the

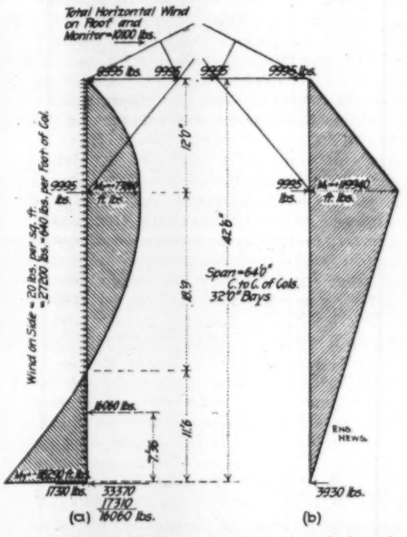

Fig. 4. Moment Diagrams for Columns of Hutchinson's Mill Buildings.—By W. H. Dunham.

analysis for the column there given was incomplete, and I submit herewith a complete analysis for the column, in connection with the accompanying diagram, Fig. 4.

The force (23,700 lbs.), to be divided between the knee braces (Fig. 3, Eng. News, Oct. 6, 1904) was obtained by taking wind on upper half of column plus total horizontal wind on roof, or,

$$13,600 + 10,100 = 23,700 \text{ lbs.}$$

I would modify this by taking one-half the wind on side above the plane of contraflexure in the column, plus total horizontal wind on roof, as the force to be divided equally between the knee braces, leaving the total wind below plane of contraflexure plus one-half of remaining wind on side to be carried directly to the foundation. In order to obtain the net horizontal reaction at base of windward column it is necessary to assume the point of contraflexure, which will be taken a distance = 18.9 ft. below the knee brace, or 11.6 ft. above the base of column.

At 20 lbs. per sq. ft. of vertical surface, the wind on side is 640 lbs. per foot of columns. The wind carried directly to the windward foundation

$$= [11.6 + \tfrac{1}{2}(18.9 \div 12)]\ 640 = 17,310 \text{ lbs.}$$

The remaining wind on side plus total horizontal wind on roof = 9,890 + 10,100 = 19,990 lbs.; this force divided by 2 gives 9,995 lbs. as the horizontal component of the force in each knee brace.

The bending moment at the knee brace for the leeward column = 9,995 × 12 = 119,940 ft.-lbs. The horizontal reaction at foot of column to balance this moment = $\frac{119,940}{30.5}$ = 3,930 lbs. Then 19,990 − 3,930 = 16,060 lbs. is the net horizontal reaction at base of windward column.

The bending moment at knee brace for the windward column = (9,995 × 12) − (640 × 12 × 6) = 73,860 ft.-lbs., and the moment at base of column must be a value such that, combined with the moments of the external forces on the column, will equal this figure.

Let the moment at foot of column = M_3; taking moments about the knee braces we have

$$M_3 = 9,995 \times 12 - 7,680 \times 6 + 19,520 \times 15.25 - 16,060 \times 30.5 = -118,290 \text{ ft.-lbs.}$$

The load on the column between the knee brace and the base is a uniform load of 640 lbs. per foot, and therefore the moment curve is a parabola. From the properties of the parabola the point of contraflexure will occur a distance below the knee brace $= \sqrt{30.5^2 \times \frac{73,860}{192,150}} = 18.9$ ft., the exact figure we assumed to obtain the net horizontal reaction, and there is no figure other than this that will cause the computations to check the assumption.

If we place the force 16,060 lbs. a distance above the base of column $= \frac{118,290}{16,060} = 7.36$ ft., the moments of the external forces will give the moment at foot of knee brace thus: 16,060 × 23.14 − ½ 640 × 30.5² = 73,860 ft.-lbs.

Assume a section of column as follows:

1 plate 18 × ⅜ ins.	= 6.75 sq. ins.
4 angles 5 × 3½ × ⅜	= 12.20
Total section	18.95
Section modulus	= 110

Then, for the leeward column,

$\frac{119,940 \times 12}{110}$ = 13,100 max. unit stress from bending,

$\frac{37,500}{18.95}$ = 1,980 unit stress from dead load,

or 15,080 lbs. per sq. in. is the total extreme fiber stress.

If we assume a base plate 2 ft. 6 ins. long and two anchor bolts outside of each flange, the lever arm of the anchor bolts about the inside edge of plate will be 2 ft. 3 ins. approximately. Neglecting the moment of dead load, the pull on one anchor bolt will equal $\frac{118,290}{2 \times 2.25}$ = 26,300 lbs.

I submit herewith, in the accompanying drawing Fig. 5, some sketches of knee-braced mill buildings as actually built that have come under my observation. I had nothing to do with the design of these buildings, and whether or not provision was made for bending in the columns I do not know. The knee braces (particularly the connections) as well as the columns would seem to be insufficient if figured rigidly from the generally accepted methods. The fact remains that these buildings, resisting high winds, have been standing a number of years and are satisfactory structures so far as I know.

If we compare Mr. Hutchinson's method and mine as applied to the column shown at "d," Fig. 5, with wind at 30 lbs. per sq. ft. vertical surface, we obtain these results:

Maximum Stresses, in Lbs. per Sq. In.	Hutchinson.	Dunham.
Fiber stress in column from bending at foot of knee brace	64,530	10,720
Pull on head of one rivet connecting knee brace to column	14,100	2,550

The other illustrations will show equally fatal stresses by Mr. Hutchinson's calculations, while figured by my method they are shown to be safe structures which perhaps may be an explanation of why such buildings stand up, without drawing on the factor of safety.

Yours truly, W. H. Dunham.

Buffalo, N. Y., Dec. 28, 1904.

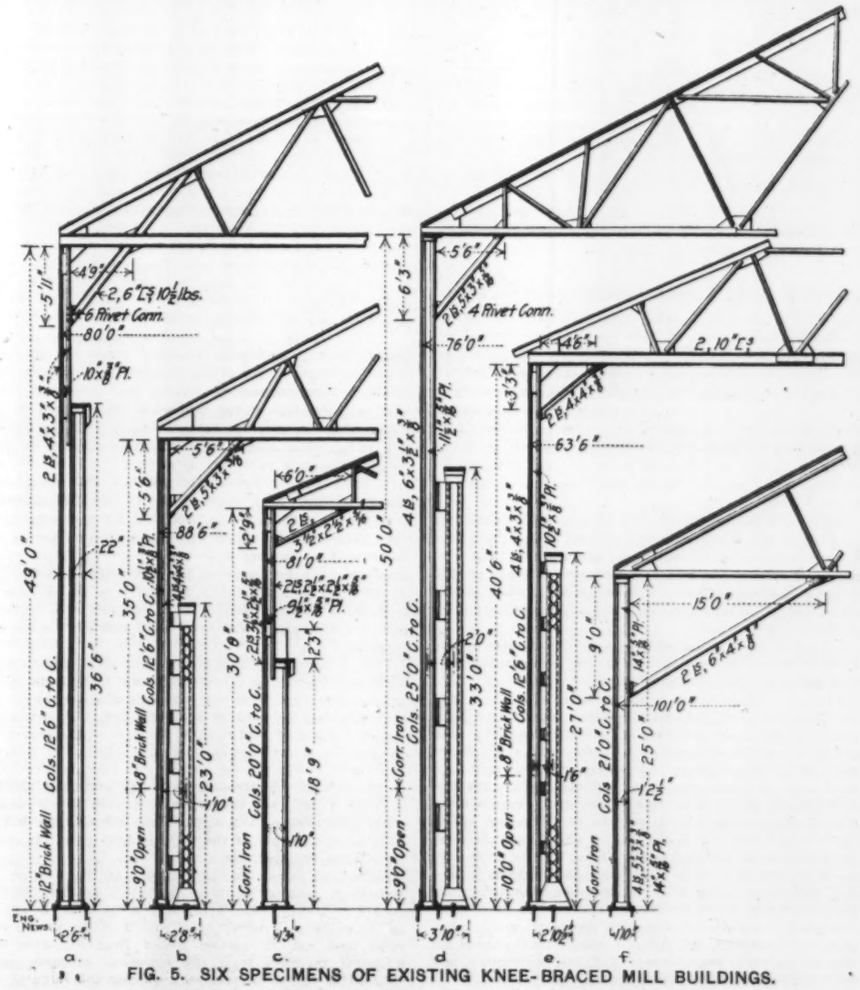

FIG. 5. SIX SPECIMENS OF EXISTING KNEE-BRACED MILL BUILDINGS.

An Explanation of Flattening and Cracking of Cast Iron Pipe and Vitrified Pipe under Earth Pressure.

Sir: In connection with the discussion of the phenomenon of the flattening and cracking of cast-iron and of vitrified pipe under earth pressure (see Engineering News, Jan. 12, 1905), an interesting explanation of such happenings was given me in 1902 by Col. R. F. Hartford, now deceased, and was as follows:

The fact that the compressive strength of sewer pipe material is far greater than any pressure that is likely to come upon it makes its rupture apparently inexplicable. It is the common notion and nearly all experiments have been made with the idea that the pipe breaks as a beam. The fact is, the pipe breaks as a cylindrical ring, and not as a cylindrical beam.

It never breaks across, but always splits lengthwise. The rupture is not necessarily the result of appreciable movement—there may be none. The movement, if any, is incidental only, and is produced by the force or load which ruptures.

The rupture is not compression, as so many imagine, but by tension. It does not crush; it is broken apart. This explains why pipe sewers of the larger sizes have not been absolute failures. They split, but are not seriously displaced, so are still operative as conduits under better conditions of load. They will stand much greater pressure in the sectional state than when whole, because they are practically hinged in the line of rupture; as a hinged arch will sustain more than a solid one of equal dimensions.

Colonel Hartford was of the opinion, to which most practical engineers subscribe, that lines of large sewer pipes, laid under average conditions and under considerable cover, which do not contain ruptured pipe are very few in number.

When displacement follows rupture, as it may when the sides can spread, the pipe collapses; the pieces become slabs, the pipe being found broken lengthwise, generally in four sections.

If there is any cross-breaking, it occurs with the pieces and after the initial rupture has taken place.

Without demonstration, Colonel Hartford submitted the following formula for a pipe considered as a cylindrical beam, uniformly loaded and uniformly supported:

$$R = \frac{hl^2}{13.5716\ dt}$$

As a cylindrical ring:

$$R = \frac{hd^2}{2.88\ t^2}$$

where h is the depth in feet of earth covering; l is the length of section in inches; t is the thickness of the shell in inches; d is the mean diameter in inches (inner diameter, plus one thickness of the shell); and R is the modulus of the rupture.

The value of R is variable, but a safe assumption is 1,500 lbs. per sq. in., although, for comparison, almost any value of R may be used, provided d, t and l are the same in both formulas.

Testing for relative values of h for a 24-in. double strength pipe, we find that, as a beam, it is 72 times as strong as it is as a ring, while a 12-in. pipe is 18 times as strong as a beam as it is as a ring.

It is only in the smaller sizes that cross-breaking under a load is possible. To make the larger sizes of such thickness that they will not rupture is impracticable.

Now acting as a cylindrical ring under opposite pressures, the rupture will occur where the bending moment is greatest; that is, at the bottom and at the top of the pipe. The bending moments at these points are equal. The pipe will break at the top and at the bottom, accompanied with rupture at the sides, forming four slabs. The preventive is to so tamp the earth that the lower half of the pipe is firmly held in place. In this case the upper half acts as an arch, and is much stronger. The pipe will break even under these conditions with bad filling, but always into lengthwise pieces, never a cylindrical beam. When it ruptures as an arch, the lines of rupture will be not quite half-way down from the top to the side. The bottom half will show like lines, or it may show but one line through the bottom. When a pipe ruptures as an arch it will collapse. It may collapse when it breaks as a ring if the load be so great that the edges shear; but in the great majority of cases the pipe may still serve as a conduit.

The conditions refer to the average back-filling of trenches.

Very truly yours,

J. N. Hazlehurst,
Chief Engineer.

Board of Public Works,
Mobile, Ala., Jan. 14, 1905.

Pending Federal Legislation Concerning Railroad Rates.

Sir: Your editorial in your issue of Jan. 5 and recent developments relative to the proposed legislation by Congress to increase the lawful powers of the Interstate Commerce Commission, seems to me to be a fit subject for discussion through the columns of Engineering News. While not a strictly technical subject, the matter, which President Roosevelt has said is of greater importance than any other now before the American people, is certainly of great interest to engineers generally, and particularly to that large branch of the profession engaged in railway work.

Stripped of all technicalities, it is proposed by Congress to place in the hands of a body of men called the Interstate Commerce Commission or some allied body, the power of naming the rate at which the railroads of this country shall do business with the public, in plain words, fixing the price at which the companies shall sell their product.

I think every engineer and railroad official fully understands the fact that railroads do deal in a commodity, and that commodity is transportation.

This transportation stands in the same relative position to the railway companies as groceries, meat, grain, flour, etc., etc., do to any company or individual handling such commodities. To a large extent this selling of transportation is governed by the same laws as govern the selling of any other commodity, and while in a sense it is a monopoly, as we often hear it expressed, it is so literally in only a certain small extent. In the larger and in the correct sense, this is not true at all. A railroad company has to do something more than lay the rails, put up its buildings, provide equipment, and arrange to take toll, something vastly more, as any man who knows the first principles of railroading is aware. The same laws governing the business of selling groceries, meat, flour, grain, etc., govern the railroad company's business, in that the customer must be consulted, his convenience, and very, very often his whims as well.

Quoting one of our engineering authorities on this matter: "Leaving out of consideration that traffic which has a choice of routes and one road is compelled to fight for it with another, a large share of the passenger business of a railroad is made up of pleasure travel pure and simple, or travel which is more or less a whim or fancied necessity." As to freight, every railroad man knows that "a large share will not be shipped unless under reasonable circumstances, or if shipped, must be accepted at a lower rate via a certain route if rates are not just what the shipper is led to think they should be," so that the fundamental principle of rate-making, recognized by all engaged in the matter, is the one we often hear made sport of and ridiculed by unthinking people, especially politicians, i. e., rates must be solely fixed by the price it will bear without discouraging traffic, and not by the cost. That this is a sound and practicable rule for rate-fixing the following table will show.

The average through freight rate in this country per ton mile since 1870, taking an average over all roads, is as follows:

1870	1.99 cents.	1897	.79 cents.
1882	1.24 "	1898	.75 "
1887	1.03 "	1899	.72 "
1890	.94 "	1900	.73 "
1893	.88 "	1901	.75 "
1895	.84 "	1902	.75 "
1896	.81 "	1903	.76 "

The enormous traffic of this country has been taken care of by our railroads and steamships at such low rates, almost half that charged by the railroads of Europe, because of the tremendous development of the past decade. This, too, in the face of the fact that wages of all classes of railroad employees have gone up 6% to 16%. In the past three years the cost of labor has advanced 10%, material used in railroad operations has also greatly advanced in price during this same period—almost 25%. As against this large increase in the cost of both labor and material, freight rates have gone up, averaging all roads only 7%. Certainly the principle of rates obeying a law based upon a natural interpretation of the basic idea of transportation is thus proven.

It is apparent, then, that rates in themselves cannot be objected to, and, if the proposed legislation is confined to granting no sweeping power of fixing these beyond seeing that the rates as established by the railroads themselves for that section of the country and for that particular traffic are charged, no harm will perhaps result.

As to the other abuses complained of, rebates, excessive switching charges, etc., every railroad man knows how much justice or truth there is in the majority of all such claims; certainly the majority of railroad managers to-day would like nothing better than to be able to shut off all rebates.

Do the people of this country want their great transportation systems turned over to the national government to be handled and managed by the politicians? I don't think so. Private ownership is the best for this country. With private ownership freight rates have been reduced to one-third to one-half lower than the cheapest rate of Europe with their government-managed roads, and this in the face of maintaining wages on a 50% higher scale. The proposed legislation is an entering wedge towards government ownership, no less. Transportation rates are, in most parts of the country, lower to-day than the traffic warrants. They have been forced down by a merciless and unwarranted competition.

A great change is taking place in our railroad organizations, and combinations are the order of the day. Enormous sums of money are being spent upon improvements and betterments of service, and these low rates will be maintained if the companies can prepare to increase their capacity for doing business with the public, and by no other means. No industrial question in this country to-day is so important as this.

In order for our country to maintain the commercial supremacy now held, it is absolutely essential that our transportation facilities be controlled by men who have the abilities and the knowledge of details to so handle the business that the very little margin between gross earnings and expenses come on the right side of the sheet. To do this, it is absolutely necessary to do as large a business as the facilities of each company will warrant, and at a rate which will cover costs and leave a margin of profit.

This is the great struggle of to-day in the railroad business. The fixing of rates by any commission is an arbitrary usurpation of the functions of government, for rates can only be fixed by a natural law, the economical law of volume of traffic. The fixing of such rates by a commission is confiscation pure and simple, for it gives nothing in return for the cutting of a rate, because, forsooth, it is to the advantage of some particular shipper to have it cut. The suggestion that such a commission could raise rates as well as cut them is hardly worth considering in the light of the existing feeling in this country against our railroads.

Instead of harrassing the railroads of this country by legislation looking to their "control," greater freedom should be given them. If any legislation at all is wanted on the question, it should be of such a nature as will give relief and not to harass. Relief from excessive and wrongful taxation, from the enormous expenses every railroad is forced to bear in acquiring the right to get closer to our great centers of shipping, and the procuring of terminal facilities so as to be in a position to serve the shipper and patrons—its customers. Every railroad engineer knows what this means—the hold-ups for higher-priced right of way which became so only because a railroad company wishes to acquire them. In fact, to those connected or conversant with the carrying on of improvement or extension work, the disadvantage under which a railroad company is forced to do such work these days is an object lesson in the grasping propensities of human nature when it comes to dealing with a railroad company. The less politics connected with railroads the better off would be all the people; but "Soak it to the railroads" seems to be the popular cry, and in the face of what might occur I think a little stirring up of views of those connected with our transportation systems or who are conversant with their operations would be timely.

R. S.

Saginaw, Mich., Jan. 17th, 1905.

(Without attempting to answer our correspondent in detail, we may remind him that from a legal point of view it was fully established, many years ago, that the business of railway transportation is a natural monopoly and that the Government has the entire right to fix the rates or prices which any such monopoly may charge. This right has been exercised in numberless instances, and in considerable proportion of the States of the Union to-day there exists a railway commission clothed with more or less power over railway rates on traffic within the state boundaries. This has been going on for years and the railways still prosper and the country still stands. Why, then, should there be a row over the proposal to give the Interstate Commerce Commission the powers which Congress intended it should exercise when it was created 18 years ago, to protect the public from undue exactions by the railway companies on interstate traffic, just as the state commissions protect the public from extortion and discrimination on local traffic. Our correspondent has an idea that no such protection is needed. If he would make a careful investigation of the actual recorded abuses of their power by the railways and to the part which these abuses have played in upbuilding industrial monopolies and throttling the small producer, he might see fit to change his opinions.

As for his fear that the proposed legislation is an entering wedge toward Government ownership. The fact is that it is exactly the opposite. The public will not indefinitely endure the exactions of monopolies. The two alternatives are either Government supervision and regulation or Government ownership and operation. Refuse the former and the latter is inevitable.—Ed.)

Lump Sum versus Unit Price Bidding.

Sir: In your editorial comments under the caption "Lump Sum versus Unit Price Bidding," in issue of Jan. 5, there are a number of points brought out which are of sufficient interest to the engineering public to warrant further comment.

The question of whether to receive bids by lump sum or unit prices is one of considerable importance to the general public, inasmuch as it may affect in quite a perceptible degree the cost of all public work either large or small. For a number of years the writer made a practice of preparing proposal sheets for unit prices only and required all bidders to submit their bids in this form. However, there are objections to this method which do not appear to be commented upon in your list of nine arguments in favor of lump sum bidding. The writer therefore trusts that he may be pardoned for commenting briefly on these points, as follows, and for brevity will refer to each of your arguments by number instead of repeating the text:

1.—It is not clear to the writer that the requiring of a lump sum bid is necessarily a confession of haste or carelessness in the making of the surveys and plans. It is simply a means to facilitate the canvassing of bids, and to show to the general public at once as soon as the bids are canvassed, the total cost of the proposed work. Under the state laws in many states where the writer is called upon to supervise the letting of contracts, it is provided that the work *cannot* be let for an amount *exceeding* the engineer's estimate of the cost of the work. Therefore the mere collection of a lot of unit prices means absolutely nothing until after the bids are canvassed, and in order to arrive at a definite total for each bid, it is necessary to have a precise bill of material upon which to compute the quantities. It is therefore just as easy to incorporate this bill of material in the specifications and require each contractor to total his own bid and submit the bid in that form.

2.—It is doubtful if any reliable or responsible contractor would consider a request for a lump sum as an attempt on the part of the engineer to shift the responsibility to the contractor, because, if the specifications are definite, as they should be, it can make no difference to a contractor whether he has given his bid in the form of total or by items, inasmuch as a change in the plans or quantities will affect his total by precisely the same in either case.

3.—It is undoubtedly true that the contractor may hesitate to leave his bid in such shape that the question of monthly estimates will be left entirely to the engineer's judgment, but it is a simple matter to require the con-

tract to sumbit a schedule to accompany his lump sum bid in order to guide the engineer in the making of partial estimates.

Again, it is neither unjust nor unfair to either party to base partial estimates upon the proportionate part of the contract executed, and although this may involve a little extra work on the part of the engineer, yet an engineer does not usually hesitate to assume extra work if it can be shown to be to the interest of his client, the employer or municipality. Objections sometimes appear to the method of allowing full monthly estimates upon the schedule submitted by a contractor on his unit price bid. The writer recalls one instance where bids were received for unit prices on work of considerable magnitude, and the bidder who was clearly the lowest and best bidder, had unbalanced his bid in such a manner that the first few monthly estimates would yield an enormous profit, while the latter part of the contract would be completed at little or no profit. The contractor evidently took this method of securing capital with which to carry on the work.

It is not clear to the writer why the probability of there being a different engineer in charge of the work upon its completion should be considered as an extra hazard.

4.—In view of the above facts it is not apparent that contractors will necessarily bid higher if required to submit lump sum bids than if permitted to submit unit prices.

5, 6, 7 and 8.—A basis for the payment of extra work due to increasing or changing the quantities or grades can be easily provided for under a separate schedule submitted with the bid.

9.—A great many contractors object to disclosing what they consider to be their unit prices on the ground that this is their stock in trade which they have learned by long experience, and they consider that to expose these prices is usually not in their favor.

The question of perpetuating the engineer's errors in estimating unit prices is one that does not concern the average contractor to any great extent. If an engineer continues to make erroneous estimates, it reflects against himself and not against the contractor.

Some two or three years ago, the writer devised a form of proposal in which he endeavored to combine the advantages of lump sum bidding with those of having a unit price schedule. In this way, the public knows as soon as the bids are read, that the total cost of the work will come within the appropriation as required by law in many States. On the other hand, the contractor, as well as the municipality or State, is protected in the matter of extras in accordance with the unit price schedule submitted following the lump sum bid. This form of proposal was received so favorably among contractors as well as municipalities that the firm with which the writer is connected, has continued to use the same, modified as required for local conditions, in all of their subsequent work. This form of proposal was used in the plans and specifications prepared by this firm for the construction of municipal water-works at Hobart, Oklahoma and Anadarko, Oklahoma, which work was to be done under an appropriation from the U. S. Government, and the writer has been informed recently that the form of proposal was so favorably considered by the engineers in charge of the U. S. Geological Surveys office, having immediate supervision of the work, that these engineers have recommended its adoption on future Government contracts of this nature.

The form of proposal is as follows, omititng the necessary legal preliminaries:

> The undersigned do hereby offer to perform the whole of the work and furnish all labor, watchmen, implements, tools, lumber for bracing or foundations, and all material and machinery of every description necessary for the proper construction and completion of the work contemplated in the annexed specifications and the plans thereto attached, at and for the sum of ———— (——) dollars.
>
> It is understood, however, that in submitting the above named price for the full completion of the work specified it is expressly agreed that the quantity of work covered by this bid is as given in the plans and specifications and the bill of material attached thereto, but that these quantities may be changed by the City Council by either increasing or decreasing the same so as to make the total cost of the work exactly equal to the appropriation, and that any increase or decrease in the amount of the work will increase or decrease the amount of compensation therefor by the amounts stated in the following schedule, to wit:
>
> Then follows a list of items covering each class of work wherein there is any probability or likelihood of any change being required.

The writer has made it a practice to include in the bill of material accompanying the specifications an itemized list covering all of the quantities mentioned on the plans, accompanied by the statement that in case of discrepancy between this bill of material and the plans, that the bill of material shall control. This gives the contractor an absolutely precise basis on which to submit his lump sum bid, and in case any changes are desired either on account of unforseen conditions affecting the cost of the work, or for any other reason whereby it becomes necessary to cut off certain portions of the work, or add thereto, the schedule of prices fixes a definite basis for such procedure.

The writer concurs most heartily in the sentiment of your closing paragraph, and he believes that if all engineers would take the stand that they must have sufficient compensation for their services to enable them to study every detail, it would lead to the upbuilding of the engineering profession and greatly restore the confidence of the public in engineering reports. Yours truly,

Clinton S. Burns, M. Am. Soc. C. E.,
of Burns & McDonnell.

509 Dwight Bldg., Kansas City, Mo., Jan. 10, 1905.

(Taking up our correspondent's objections and queries seriatim, it will be granted that asking for a lump-sum bid is not in itself a confession of haste or carelessness in making the surveys and plans; but, when this requirement is accompanied by one or more general clauses that attempt to make the contractor guarantee the correctness of the engineer's work, including his estimate of quantities, the contractor will ask:

> Why are they so anxious to have me submit a lump-sum bid with a guarantee to furnish the completed structures substantially as shown in the plans, if they are sure of the correctness of their estimates and designs?

So far as the totaling of the bid is concerned, the contractor would be quite willing to submit a total with his itemized bid, and, as a matter of fact, he often does do so. He does not like to submit a total by itself as his bid, for reasons enumerated in our issue of Jan. 5.

The mere lump-sum bid by itself, we repeat, does not necessarily indicate a desire to shift responsibility, but, of the scores of contracts that have passed under our eyes, few lump-sum contracts are unaccompanied by general clauses which attempt to bind the contractor to make no claim for extras, which is admitted to be one of the main objects of the lump-sum contract.

Regarding monthly estimates, we concede that "it is neither unjust nor unfair to either party to base partial estimates upon the proportional part of the contract executed"—provided that the work is all of one quality. For example, where the contract is all grading, or all concrete, the proportional part is, as a rule, readily estimated; but, where there are a score or more of different items, earth, rock, masonry, piling, etc., it is not an easy matter to say what "proportional part" all the earth, for example, bears to the lump-sum bid. In fact no two engineers will agree on the value of such a "proportional part."

As our correspondent says and as we have editorially pointed out a number of times, bids are often unbalanced so as to secure very profitable prices on the items of work that must be done first. This, however, is usually a risky procedure on the part of the contractor; first, because it may cause the rejection of his entire bid; second, because a change in plans after the contract has been awarded, may increase the low-priced items and decrease the high-priced items; third, under some contracts, it is possible to award all or part of the work to any bidder at his unit prices. In any case, if good surety company bonds have been furnished, and if the contracting company is known to have performed other similar work satisfactorily in the past, there is little to fear from such unbalancing of bids.

Regarding the extra hazard arising from a possible change of engineering administration after the award of the contract, we could cite several examples. It will perhaps be sufficient to say that the general clauses in almost every specification put the contractor's fate in the hands of the man who interprets them. Even the so-called specific clauses are usually subject to wide variations in interpretation. Slope-wall, for example, was made to cost $2.50 per cu. yd. under one engineer, where previously under another engineer the average cost had been $1.50. All other conditions were precisely the same, and the same specifications were used. Furthermore, stretches of these two slope walls may be seen to-day, showing the less expensive wall to be in perfect condition and as serviceable for its purpose as the more expensive wall. In neither case was there dishonesty of any kind. The fault was with the specifications which were ambiguous in that they left much "to the satisfaction of the engineer."

It is true that many contractors try to conceal their unit bids by unbalancing. The danger of doing this, however, is a strong incentive not to unbalance. Moreover, there are many contracts where the bulk of the work is of one class, in which case unbalancing of the price on the main item is an impossibility.

Regarding the perpetuating of engineer's errors where lump-sum bids are required, we do not use this as a reason why contractors object to the lump-sum method, but as one reason why engineers can not afford in the long run, to use the lump-sum method. This, as stated in our editorial article, is one of the most serious objections to the lump-sum method, or to any modification of it, such as is suggested by our correspondent.—Ed.)

Concerning Re-Section in Plane-Table Work.

Sir: For the sake of students who may over-estimate the practical value of the processes described in the article on "The Three-Point Problem in Plane-Table Surveying," by Mr. A. Liano, which appears in your issue for Dec. 29, 1904, I would like to make a few comments.

The direct solution of the three-point problem is not attempted with the plane table by experienced operators; it is not a practical method and it requires much more time than the indirect solution. It is not practical on many grounds, but chiefly because:

(1) The plane-table sheet is usually covered with topographical details, generally in lead pencil, and construction lines cannot be drawn across the topography without soon leading to endless confusion.

(2) On account of unequal changes in the contraction and expansion of the paper, plotted points will not preserve their relative position with exactness. The experienced topographer is rarely satisfied with a location from three points only. Unless four or more points are used in locating the new point he has no check on the accuracy of his work. The new station is then an "n"-point location,* and the indirect process becomes still more desirable, if time involved is of any importance.

Mr. Liano refers to the article on the plane-table which appears in the 1880 Report of the U. S. Coast and Geodetic Survey, apparently ignorant of the fact that this paper has been amended and rewritten by Asst. D. B. Wainwright and appears as "A Plane-Table Manual" in the Report of 1897-98. This manual should be carefully studied by any person who wishes to know the methods approved and the theories involved in plane-table work.

The indirect method consists in a series of approximations by means of "triangles of error," which continually become smaller as closer approximations to correct orientation are made.

Mr. Wainwright, unfortunately, does not refer to the very excellent method attributed to Bohnenberger (1765-1831) by Bauernfeind in his Vermessungskunde (Vol. II., 5th ed., 1876, p. 165). This method enables a very exact estimate to be formed as to the location of the true point, by finding the intersection of lines drawn, or imagined as drawn, through the vertices of the equal angles of two triangles of error. Frequently these triangles are so very small that it is not necessary to actually draw the lines between the vertices, as the intersection may be estimated within limits of graphical error.

Practically, when four or more points are used in making the new location, the lines will often fail to give an exact intersection, on account of changes in the paper and small graphical errors. The operator must then use his judgment in reconciling the small discrepancies, paying due regard to Lehmann's precepts (see p. 434 of the Manual) as well as to the various triangles of error obtained, in fixing upon the most probable location.

Much has been written regarding the three-point problem and its solution by analytical and geometrical methods, but the methods of continual approximations are often overlooked; yet these are very convenient analytically and the most practical of all in connection with plane-table work.

The tracing-paper protractor method (Wainwright, p. 437; Bauernfeind, p. 166) which has been known for a hundred years (See Puissant, "Traité de Topographie," 1807) is a very useful method for the novice, especially so since "n" points can be used simultaneously in locating the occupied station. For field purposes, especially with much wind, this method would be cumbersome and not very practical; but it is, perhaps, the best known method of plotting a station graphically where angles have been observed with a sextant or theodolite between stations numbering four or more, and in the office and in the hands of a careful draftsman it gives results of a high degree of precision.

The three-point problem, or more broadly, the problem of "backward-cuts," has exercised the ingenuity of able mathematicians for centuries and it is not easy to find anything new or original in the way of solutions, graphical or analytical.

The history of the problem is summarized by Jordan in his "Handbuch der Vermessungskunde." 5th ed. Vol. II., 1897; p. 318. A sixth edition of this valuable work has recently appeared (1904).

Very truly yours, *Horace Andrews.

Albany, N. Y., Jan. 2, 1905.

Sir: The methods of solution of the three-point problem with the plane-table, as given by Mr. Antonio Liano in your issue of Dec. 29, 1904, are valuable as exercises in

*See App. 13, U. S. Coast Survey Report, 1864, Analytical solution by Schott.

mathematics in giving to beginners a clear idea of the principles involved; but their practical application in the field is very limited. The principal disadvantages are: the great length of time required, the mutilation of the plane-table sheet by drawing many lines on it, and the inaccuracy. The methods are, theoretically, accurate, but under the average conditions of field work the errors in the graphical operation and from other sources become appreciable—that is, the lines will not intersect in a common point and the operation when finally completed gives only an approximate location, and the exact point must be found by trial.

Where points are being located by intersections (and in many cases these are very acute), it is necessary, in order that the intersected points be accurately located, that there should be no appreciable error in the location of the plane-table stations from which they are sighted.

A method which is extensively used by the topographers of the U. S. Geological Survey is as follows, viz:

The plane-table is placed approximately "in azimuth" by means of a box compass, or by selecting a point on the sheet as nearly as can be estimated to where the point sought will be and the plane-table oriented on the most distant one of the three points. The three points are then sighted and lines drawn from them on the plane-table sheet. The lines will usually form a small triangle of error, and by inspection it becomes evident which way the plane-table must be swung in azimuth to make the lines intersect in a common point. Several rules have been given for finding the point sought after having obtained the triangle of error, although when the point is on or near the circle passing through the three points the location is uncertain.

1.—When it is within the large triangle it is also within the small triangle.

2.—When it is without the large triangle it is on the same side of the longest line as the intersection of the other two lines.

The desired point can always readily be found by these two rules, remembering that it is on the same side of all the lines (looking along them from the triangle of error) and at distances from them proportional to their lengths. A second point is selected by help of the rules, then the plane-table is oriented by the most distant point and the operation repeated as before until the three lines will intersect in a common point. To test the location other located points visible from the station are sighted to see if the lines drawn from them also pass through the point.

It sometimes happens that one of the three points is wrongly located. This may be detected and a perfect location secured by using all points visible from the station.

The ideal three-point location is obtained when the lines from two nearby stations intersect at right angles, and the third one is very distant for control in azimuth.

The above method is very quick and precise. It often happens that the lines require no shifting, when a good compass is used for orientation.

The lines are, of course, drawn very short near where the point is located, and are easily erased for filling in topographic details.

Very truly yours,

D. L. Reaburn, Assoc. M. Am. Soc. C. E.,
Topographer, U. S. & C. Boundary Survey.

Washington, D. C., Jan. 12, 1905.

(Proof of the above letters was submitted to Mr. Llano with an opportunity to make a reply. We append his answer as follows.—Ed.)

Sir: Your correspondents' criticisms appear to me to affect my method of solution very little, if at all. Both writers refer to the inconvenience and confusion caused by having construction lines mixed up with the platted topography. This objection applies to all methods. It should be observed, however, that the number of construction lines in the two methods described in my article is very small. Besides, the objection is not really so formidable as some think; for an experienced draftsman can estimate points of intersection very closely, and so he has to draw only short segments of lines. Referring to Fig. 5 of my article, for instance, it is only necessary to draw a small segment of the perpendicular $m_1 p_1$; the line a o_1 is not actually drawn, it being sufficient to mark its intersection with $m_1 p_1$.

The true reason why the "direct solution" is not "attempted" is that the methods heretofore proposed for that purpose are more or less inconvenient and lacking in generality. I think every engineer will grant that, as a rule, an exact method is preferable to a tentative one. I may state that, before the publication of my article, I communicated my method to one of the leading American authorities on surveying, and that he, after trying it in the field, pronounced it most satisfactory and expeditious, and "an improvement on the cut and try, or method by trial," commonly used. This trial method is the one advocated by your two correspondents.

One of these gentlemen states that I refer to the 1880 Report of the Coast and Geodetic Survey, "apparently ignorant of the fact that this paper has been amended and rewritten by Asst. D. B. Wainwright, and appears as 'A Plane-Table Manual' in the Report of 1897-98." He adds that "this Manual should be carefully studied by any person who wishes to know the methods approved and the theories involved in plane-table work."

One would judge from this that, so far as the three-point problem is concerned, Mr. Wainwright's paper is different from, or an improvement upon, Mr. Hergesheimer's (the 1880 paper); but, as such is not the case, the critic's statement and reference are entirely irrelevant. Mr. Wainwright's treatment of the three-point problem is but a partial reproduction of Mr. Hergesheimer's, and Mr. Wainwright himself has a foot-note that reads: "See U. S. Coast and Geodetic Report, 1880, for additional methods of solution." Although I was perfectly familiar with Mr. Wainwright's paper, I referred to the older paper, both because the latter is, in this respect, more complete, and because it is the original source whence the other derived its information.

As to checking the work by sighting on four or "n" points, there is nothing in my method that conflicts with such checking. Nor is there anything that prevents its application to the determination of the required point by successive approximations (or by "compromise," as Mr. Wainwright puts it), when, on account of the paper having become distorted, the point cannot be accurately located. The method can be advantageously used for approximate as well as for exact determinations. It should also be remarked that, while the distortion of the paper may have to be considered in surveys covering very large areas, and in which the work requires many days, it seldom has to be taken into account in ordinary topographic surveying, especially if the paper has been properly seasoned. It should be borne in mind that the plane-table is adapted only to rough work, and that, where any refinements are necessary or desirable, a more accurate instrument and more accurate methods should be used. It is not necessary that a point located by resection on three or more points should be platted in its absolutely correct position; nor is it possible, in the majority of cases, to realize this condition. Any point thus located is used merely as a temporary station from which to plat some of the topography in its approximate position, and should not be employed as a point of reference for the location of other points. Unless the positions of all such temporary stations are determined by sighting on controlling points located by accurate triangulation, the errors will accumulate to a very great extent.

The "expeditiousness" and "simplicity" of the "indirect methods" will be readily appreciated by referring to either of the papers mentioned above. Lehmann's method, which is "the simplest and most direct," requires for its exposition two whole pages (and what pages, Mr. Editor!) of the Report, besides a full-page diagram. One has to learn first what is meant by the "great triangle," the "great circle," and the "triangle of error"; and then follows an enumeration of "Cases" and "Rules" leading to—what? a determination of the required point? No, indeed; only to the "estimated position of the point." Having this "estimated position," "a new orientation is made. If the lines from the three (notice that nothing is said of 'n') stations now intersect at that point, it proves the estimate to have been correct. . . If a new triangle of error is formed, it indicates a faulty estimate, and the operation must be repeated."

I wish to state that the foregoing is not intended as a criticism of either Mr. Hergesheimer's or Mr. Wainwright's work, but simply of the inconvenience and unsatisfactoriness of the trial methods It is very significant that neither the "very quick and precise" method partly described by one of your correspondents, nor any other similar methods, are given in standard works on surveying, such as Johnson's, Raymond's, Carhart's, etc. These writers content themselves with describing the tracing-cloth method, notwithstanding its many shortcomings.

A man who has used a method for several years becomes so accustomed to it that he finally comes to regard it as the simplest thing possible or imaginable. The case, however, may be different with the novice. Let the description of the trial method, as given in either of the reports already referred to, be put in the hands of a surveyor not familiar with any solution of the three-point problem. If he cannot read and understand my method in one-quarter the time required to even understand the other, and if he cannot use my method with quickness and precision in one-quarter the time required to use the other in the same manner, I will acknowledge that from a practical point of view both my solution and my article are worthless. This statement is not intended as a hyperbole. I have known several experienced surveyors who, after reading and studying the "Manual," were unable to use, or even to understand, Lehman's "very quick and precise" method.

In conclusion, I should add, "for the sake of students," that the fact that a problem "has exercised the ingenuity of able mathematicians for centuries" should not deter any one from attempting a solution. It is certainly discouraging to be told that it is idle for you to attack a problem in elementary geometry before you have risen above Euclid, Archimedes, Newton, Lagrange, et al.

Yours very truly, Antonio Llano.

Scranton, Pa., Jan. 20, 1905.

Notes and Queries.

A. H. H. wishes information regarding the u... barium carbonate or oxide as a water purifier. He ... formed that it is used in Germany, but not extensive... account of its high cost.

H. Kleinschmidt, of the U. S. Reclamation Se... Salt Lake City, Utah, desires information as to the ... of ice on stream flow as related to gage rod reading... asks which is more probably correct, the gage re... obtained by cutting ice free from the gage rod and ... ing the water surface, or deducting the thickness ... from the above reading, and calling that the ... reading? Is water in a stream, frozen solid from ... to bank to an indefinite depth, for a distance of ... hundred feet, ever likely to be under pressure ... to cause an accelerated flow? The case in que... where a current meter measurement at an open pla... stream gave a discharge over 50% less than that ind... by the gage reading obtained by cutting ice free ... gage rod and reading the water surface.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the American Soci... of Civil Engineers was held at the Society Hou... in New York City on Jan. 18 and 19. The business proceedings occupied only one session and the remainder of the first day was devoted to a luncheon and informal gathering of the members during the afternoon and to a formal reception in the evening. The second day was devoted to an excursion to the new freight terminals of the Pennsylvania R. R. at Greenville, N. J., and to other points of interest to engineers along the New York harbor front. In the evening there was a lecture at the Society House by M... W. H. Jaques, M. Am. Soc. C. E., on "The Development of Solar Evaporators." The lecture was followed by a "smoker."

DIRECTORS' REPORT.—The first business taken up was the reading of the reports of the Board of Direction and of the Secretary and the Treasurer. The report of the Board of Direction showed a net increase during the year of 279 members, giving the Society a total membership of 3,203. The losses by death during the year were 32 members. There were 2,776 accessions to the library during the year having an estimated value of $2,850. The usual volumes of Proceedings and Transactions were issued during the year at a cost of $10,012. In addition there were published advance copies of the papers submitted at the International Engineering Congress at St. Louis. During the year the Society purchased the 25 × 116 ft. plot adjoining the Society House, paying $100,000 for it. The money for this purchase was secured by borrowing $120,000 on bonds. The Society now owns a plot of 75 ft. front and 113 ft. deep, valued, without buildings, at $255,000. Plans are now being prepared for the addition to the Society House, which is to cover the new lot, and it is expected that construction of the addition will go on during the present year. The report reviewed briefly the Society exhibit at St. Louis, the visit of the members of the Institution of Civil Engineers, and the work of the International Engineering Congress. The cost to the Society of these affairs was $17,579, excluding the cost of entertaining the visiting members of the Institution, which was defrayed by private subscriptions. It is important to note here that, notwithstanding the extraordinary expense of $17,579 just mentioned, and the additional interest charge of $3,243 on the increased bonded debt, the balance on hand at the end of the fiscal year was $5,003 greater than it was one year previous. The details of the receipts and expenditures of the Society during the year are given in the accompanying balance sheet from the Secretary's report.

COMMITTEES' REPORTS. — Following the business reports just outlined, reports were received from the committees on Tests of Cement, Special Rail Sections and Concrete and Concrete-Steel. The committee on cement tests reported progress, and asked to be continued. The committee on rail sections reported that it had conducted inquiries during the year to determine what the behavior of the present sections had been in practice. So far as had been discovered, there was no general complaint of the present sections, either from the railways or the manu-

fact ers, and on this showing the committee did not em it advisable to recommend any change for e present. The committee on concrete and con te-steel reported progress. Its first work had en to adopt a name by which to designate the ombination of concrete and steel, and the ter inally adopted was reinforced concrete. Reque was made, therefore, that the official name of e committee be changed to Committee on Con ete and Reinforced Concrete. This request was anted by vote of the convention. The report continued with the statement that the general committee had been divided into several sub-committees, each having a special phase of the work in charge. Among these sub-committees, the e on tests had outlined a scheme of tests of reinforced concrete, and had arranged with a number of engineering school testing laboratories for the prosecution of the work. The committee asked to be continued, and the request was granted by vote of the members.

NOMINATING COMMITTEE.—The following members were put in nomination, and elected by vote to membership in the nominating committee for officers for 1906: C. L. Harrison, J. R. Freeman, C. F. Stowell, Jas. K. Lyons, C. F. Loweth, J. A. L. Waddell and J. D. Isaacs.

NEW BUSINESS.—Under the head of new business, Mr. Samuel Whinery introduced a resolution authorizing the Board of Direction to investigate in detail the question as to the duty of the Society, to suggest or name, when requested, suitable men for employment on expert commissions or engineering commissions. In introducing the resolution, its author pointed out that there was no provision of the constitution that covered this matter, and he considered it desirable that such action should be taken as would definitely determine the policy of the Society in the future. There was a very brief discussion, which brought out the fact that for some years the policy of the Board of Direction had been to refuse to suggest or name members of commissions. The resolution was passed by vote of the members.

AWARD OF PRIZES.—It was announced that the awards of prizes for papers presented in 1904 were as follows: Norman Medal to Emile Low; Rowland Prize to G. C. Kenyon; Collingwood Prize to H. J. Wild.

ELECTION OF OFFICERS.—The election of officers resulted in the selection of the regular nominees: President, C. C. Schneider; Vice-Presidents, M. L. Holman and Emil Kuichling; Treasurer, Joseph Knapp; Directors, A. L. Bowman, Morris R. Sherrerd, H. Bissell, Edwin A. Fisher, Wm. B. Landreth and Geo. S. Pierson.

THE RELATION OF THE ENGINEER TO THE ARCHITECT.*

By Corydon T. Purdy.†

The advent of the rolled beam has wrought a new era in architecture. This era is contemporaneous with our own works, it is being evolved in our own times; and we have not yet adjusted ourselves to it, not even we here in America. This does not mean that there were no structural problems before our day, but rather that the use of steel has brought with it structural possibilities, indefinitely greater than anything that preceded, so that it practically constitutes a new age in building construction. Many of the great designers of the Middle Ages must also have been great engineers. Their command of geometric functions may have been as great as ours. From a structural standpoint, their work will always remain notable—some of it remarkable—and the new era does not signify that we know more than they did, but that we now have a material for our buildings that admits of forms of construction of which those masters could not have dreamed.

The characteristic features of this new era are the substitution of the steel frame for the heavy masonry walls of massive construction, great height of buildings, larger openings in walls, wider spans in rooms, magnified requirements for ventilation and sanitation, electric light and power, the modern elevator, and the great multiplicity of structural and mechanical problems which these things involve. These characteristics do not pertain directly to the utility of the building nor to its artistic treatment, but to structural conditions involving technical education and experience. This is true, though the increased height of buildings and the great openings in exterior walls may call for a modification in the artistic treatment, and though the problems of utility may have been almost immeasurably magnified.

This new era, with its new conditions, partially explains why the engineer has suddenly, as it were, become a distinct factor in the building problem. It is because of this enormous expansion of problems involving technical knowledge. The other reason is not far to find; it is because the methods of treating these problems have been elaborated during the last century, and particularly during the last thirty years, upon a basis which affords much more accurate and more definite results than anything, so far as we know, in use before the present time.

While some of the vaulted ceilings and domes of the old world make men wonder how the designers calculated so closely and did their work so well, it is undoubtedly true that a large part of even the best buildings constructed prior to the advent of steel were dimensioned and fixed structurally upon the basis of experience and precedent. Every new building called for careful comparisons and the judgment of the most experienced persons. The actual calculation of stresses and strains was unknown. Now this is changed. The rule is the other way in every up-to-date architect's office. The dimensions and sizes of all details of construction, as well as the mechanical features of modern buildings are calculated, accurate and definite results are sought, and we pay less and less heed to what the dimensions and sizes of the same details were, in comparison, in other buildings. We lean on our computations, and not on precedent. Judgment is not eliminated, but in a large measure it is transferred, and the experience required is the experience of the technical man rather than that of the observer.

To put it briefly, structural and mechanical problems in building work were comparatively few in number in all times preceding the advent of rolled beams, while accurate and definite methods of treating such problems, particularly those involving the strength of materials, were at least relatively crude and unsatisfactory and electrical problems were entirely unknown. In these days such problems fairly burden every design, and they are susceptible of definite calculation and accurate determination. Unless we get this point of view, we shall scarcely be able to appreciate what an evolution is really going on at the present time in the relation of the architect to his work and in the operations of his office or to realize that these changing processes are not yet completed. Attention is called to this, in the beginning, because we can not determine what relation the engineer can most profitably hold to the building problem and to the architect, unless we approach the question with the largest possible conception of these new conditions which the construction of modern buildings has wrought in architectural methods and requirements.

The engineering profession, as a profession, is comparatively a new thing. Compared with that of the architect, it is really in its infancy. The employment of architects, their work as designers, and their supervision of construction are fixed things the world over; their place in the business world, and even their standard rate of compensation is universally conceded. With an engineer it is entirely different; he has been struggling, particularly during the last generation, for an acknowledged place as a professional man, and for a like independence. This is really true in every department of engineering. The business world in these latter years has finally come to recognize him as a man of some importance, but it still expects him to work on a salary, unless he is able by some means to maintain himself independently, and this seems to be as true of the man who builds a transcontinental railroad or tunnels a mountain as it is of the youngster that works over a drafting board.

When it comes to the engineer working on architectural problems, the commentary is doubly true, for it is practically a new field for technical effort. The engineers taking up this work, and their number is constantly increasing, appreciate these conditions. We shall see during the next generation, however, that they are a strong body of men, also, that they are ambitious, and that they will unquestionably aspire to any authority or position which circumstances may open to them. It may, therefore, be confidently predicted that any practice by the architectural profession which fails to appreciate these men at their real worth, and the rapid development of the engineering profession as a whole, will, ultimately, come to naught. If a relation is ever established between the engineer and the architect, which will be conceded to be the proper one by both professions and by the public, we may fairly expect that relation to be one which will work for the advantage of all concerned—the architect, the engineer and the owner.

Ten years ago, when the writer moved his office to New York, he was told that there was no chance for an engineer in that city; that excepting a few who regularly employed engineers in their office force, the architects depended upon one of three or four of the great iron manufacturers of New York for their steel designing, and that that arrangement was a fixed one in the architectural practice of the city. He was told that the custom was so thoroughly established that it could not be disturbed. The office was, nevertheless, started in the belief that such a custom would go to pieces of its own accord. In a very large degree this has already happened, and it is a fair illustration of what will eventually happen to every relation between the men that is not reasonably considerate of all interests concerned.

The structural engineer ordinarily includes in his part of the work the structural framework of the building, be it much or little, the foundations, and also the masonry whenever it becomes complicated or questions of strength are involved. This part of the designing of a building can be accomplished in several different ways. (1) The architect may do the work himself, without assistance. (2) The architect may have the work done by some manufacturer. (3) The architect may have the work done by the builder, or the owner, with his consent, may have it done in that way. (4) The architect may employ the engineer as a part of his own force. (5) The architect may associate the engineer with himself as a partner. (6) The architect may employ a consulting engineer, who has his own independent office and practice. (7) The architect may be associated with such an engineer, employed directly by the owner, without any personal arrangement with him in relation to the matter, or (8) the engineer may have control of all the work, with the architect more or less subordinated to him.

All of these methods of getting the work done are in vogue at the present time. It is a wide divergence of practice and certainly a very undesirable condition of affairs. With engineers in other departments, particularly in electrical work and heating and ventilating, the practice is more uniform, but not sufficiently so.

The responsibility rests chiefly with the architect. Where the work has been done by men in the employ of the manufacturer or builder, in many cases it has been so because they wanted it, and when they have been employed by the owners, it has usually been because the owners required it; but outside of these influences, the architects have been in control of the work. They have decided how it should be done, and the engineer could do nothing but acquiesce in their wishes.

This wide divergence of action has, first of all, grown out of the varying conditions among the architects themselves. Some have technical training, and their best work pertains to the structural part of their problems, while others, and among them some of the best designers, have little or no taste for construction. Some architects can afford to give their own time to structural de-

*A paper read at the Annual Convention of the American Institute of Architects at Washington, D. C., January, 1905.

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BALANCE SHEET FROM SECRETARY'S REPORT SHOWING RECEIPTS AND DISBURSEMENTS OF AMERICAN SOCIETY OF CIVIL ENGINEERS FOR THE YEAR 1904.

Receipts.		
Balance on hand December 31st, 1903, in Bank, Trust Company, and in hands of Treasurer		$26,890.54
Entrance Fees	$8,275.00	
Current Dues	35,684.24	
Past Dues	1,210.00	
Advance Dues	16,639.30	
Certificates of Membership	354.75	
Badges	1,715.30	
Sales of Publications	2,660.97	
Advertisements	30.00	
Interest	1,156.13	
Compounding Dues	840.00	
Library	83.70	
Annual Meeting	480.00	
Binding	3,271.48	
Bond and Mortgage	175,000.00	
Entertainment of British Engineers.	2,243.75	
International Engineering Congress.	2,615.15	
Miscellaneous	49.23	
		252,489.00
		$279,379.54

Disbursements.		
Salaries of Officers	8,475.00	
Clerical Help	11,101.88	
Caretaking	1,770.36	
Publications	13,028.11	
Postage	3,541.01	
General Printing and Stationery	1,963.01	
Badges	1,429.85	
Certificates of Membership	193.80	
Binding	1,774.94	
Library	976.43	
Maintenance of House	263.08	
Heat, Light and Water	1,097.36	
Betterments	37.00	
Furniture	100.80	
Annual Meeting	933.36	
International Engineering Congress.	13,579.27	
Prizes	111.00	
Advertising Commissions	18.52	
Interest and Insurance	5,933.61	
Bond and Mortgage	55,000.00	
Entertainment of British Engineers.	2,151.25	
Building and Lot	101,095.50	
Current Business	689.93	
Louisiana Purchase Exposition	4,000.00	
Petty Expenses	186.98	
		229,452.05
Balance on hand, December 31st, 1904:		
In Union Trust Company	$42,448.35	
In Garfield National Bank	6,494.14	
In hands of Treasurer	985.00	
		49,927.49
		$279,379.54

tails, when it would be folly for others to do so. Some architects have a business sufficiently large to warrant the expense of regularly employing competent men in their own offices, while others cannot afford such an expense. In some cases the cost of the best technical assistance is unhesitatingly met by owners, while other work is done under circumstances which makes the employment of engineers almost prohibitive.

To some extent, this difference in practice has grown out of a fear of trusting to outside help. Some architects have been willing to try it, while others have not. The fear has been two-fold, that the work would not be done well, and that the building could not be designed to advantage unless the work was all kept together. Some times it has been the former, some times the latter, and occasionally it has been a dread in both directions.

The divergence of practice is also due to a failure to appreciate good work. The great structures of our cities vary in strength and stability, and in every other structural characteristic from the wretchedly poor to the wastefully good. The engineer is not to blame, he does the best he can, but he is to blame who chooses an inexperienced or incompetent man for important work. It is a fact that young men not long out of school and men whose technical knowledge is very limited are employed in offices to do work for which they could not be considered qualified, in any of the leading engineers' offices of the country. They fail to do the wise thing. They can't help it. Sometimes the result is lacking in some essential feature, and sometimes it is only the lesser evil of extravagance; but whether it is the one or the other, ordinarily, both the architect and the owner fail to realize its imperfections. It is only now and then, when such structures come under some extraordinary test, that the weakness becomes apparent.

There remains, however, another explanation of this divergence, a more important one perhaps than all the others put together, and that is the cost. Undoubtedly, this is often the reason why inexperienced or incompetent men are employed. The question is asked too often: "How can we get the work done at the least expense," and there are not a few extreme cases on record where the architect has tried to employ a consulting engineer by taking bids to see who would do the work for the least money. The results produced by such means are, to say the least, very unsatisfactory, and words can hardly tell how discouraging and humiliating it is to the competent engineer who is trying to do good work.

Some of the ways in which structural designing is now being done ought to be ruled out altogether, and this is particularly true of the one already referred to as the common practice in New York ten years ago. The day is coming when no architect who values his reputation will venture to receive assistance from a manufacturer or his employees, whether that assistance is paid for in a regular way or not. It might also be added that the day is coming when no engineer regularly employed by a manufacturer, or practicing as such himself, will expect to be called on for such services. It is an old saying that: "No man can serve two masters," and it is because this is true that this relation, sooner or later, is certain to disappear; in many cases it works to the owner's distinct disadvantage.

The steel frames in some of the most notable buildings, both of the East and West, have been designed by the builder or under his immediate direction. This is particularly true of some of the first high buildings. The builders' confidence in the practicability of the new methods of construction, and his willingness to share in the responsibility of their introduction, made that way of doing the work acceptable and pardonable when these first buildings were erected. The same method, however, has been followed on other important buildings during later years. Its continuance is partially due to the existence of the precedent and partially to the influence of the realty element which has recently taken so large a hold of the building business of the country. It is, however, an undesirable relation, from the architect's point of view, and that is sufficient to prevent its general adoption.

The employment of engineers by an architect as a part of his own force is also open to at least two serious objections, particularly when it is done in an office of moderate size. The character of the work which is ordinarily produced under such circumstances is not likely to be of a high order. The other objection comes from the other point of view. The subordinate and limited character of the service ordinarily required in such cases is certain to be distasteful and not acceptable to the most competent engineers. For these two reasons it is a method that probably will not be permanently maintained. The structural and mechanical problems in any office, be it large or small, are likely at any time to require the services of men whose training and ability will compare favorably with that of the architect himself; or, to put it another way, these problems may at any time become the most important problems connected with the architect's business. The day is already dawning when the owner is going to appreciate this fact and is going to require the same ability and the same experience in those departments that he expects to get from his architect in other ways. When that day fully comes, this method of handling these problems, in all, except possibly the very largest offices, must disappear. Indeed, as rapidly as architects come to appreciate the importance of good structural designing they will themselves be dissatisfied unless they can have the very best, and it will be almost impossible for them to get the best from a salaried man without a greater expense than they can afford. Even in the largest offices it will eventually prove difficult to keep the service to a high standard without occasionally varying the practice or making changes in the personnel of the department. This is possible, because no man working under a salary will maintain as high a standard of efficiency as he would maintain if he were working for himself. There are few exceptions. It is human nature. Moreover, all men are prone to work in ruts and to repeat their faults. If an architect is constantly dependent upon one or two men in his own office, there is no getting out of these ruts or escaping from these faults, unless it be by occasionally changing the method of having the work done, or by changing the employees themselves. One of the leading engineers of the country, in speaking of this matter, recently said: "The consulting engineer, in general practice, may be expected not only to have better and more adequate facilities, in the way of technical assistants, for doing a given piece of work, but he can also bring to bear upon this work a much greater amount of experience and knowledge derived from the greater number and variety of cases handled through his office." He added: "I have had occasion to note several times the limited scope of the knowledge and experience of the technical assistants employed on salary by the architects and contractors."

The employment of the engineer by the owner as the associate of the architect or in general charge of the work, is also undesirable; as an associate it divides responsibility; in charge of the work, it subordinates all other considerations to the structural. Eventually it would be humiliating to the architect. It does not conserve the best interests of either the owner or the architect. Both arrangements are a mistake, and neither can attain a general acceptance, in or out of professional circles.

On the other hand, consideration of such a plan can not be turned away lightly. If some solution of this difficulty is not found, if some systematic effort is not made to "standardize" this relation, if such an expression may be used, the engineer will strive to push himself forward in just such ways as these, and will meet with encouragement from the public. An opportunity to take the lead appeals to his ambition. He is also almost always a practical man of affairs. On these accounts, if the situation is allowed to drift, it may never be possible to arrive at an understanding between the two professions for a uniform practice and a division of authority which may in time become fixed by public usage. And this is not an abstract theory. A good illustration of both arrangements has come to the writer's attention, while these words are being written. In one case the owner of a fifteen-story building employed the engineer to design the steel construction of the building without reference to the architects. In the other case, a power house was designed by the engineers and no architect was employed until the services of one became absolutely necessary, and then only to serve in a subordinate relation.

Objections are also repeatedly made to the employment of a consulting engineer. It is urged that the dividing of the work is a disadvantage to the architect, and that it obstructs and delays the men employed in the architect's office on other features of the design. The desire to keep the work under personal control is usually due to this notion; but sometimes it is due to a feeling of satisfaction in doing everything one's self, and occasionally it is born of the wish to monopolize the credit of every achievement with which one has to do. These ideas and desires are not only in the larger offices, where the volume of business is sufficient to warrant their gratifications, but architects having smaller practices are governed by the same ideas. A much greater difficulty, however, is the question of compensation, to which reference has already been made. The expenditure of so large a part of the architect's commission in one sum always seems a hard thing to do.

These difficulties, and these only, seem to stand in the way of the employment of a consulting engineer. To all other relations there seems to be an objection which makes them impossible, an objection which will surely prevent their final acceptance by all concerned. It might, therefore, be well to inquire particularly into these difficulties which appear to stand in the way of the employment of the consulting engineer who has a practice of his own independent of the architect. Are the objections unsurmountable? Has the relation advantages of sufficient importance to warrant changing other methods which we are using in order to secure its adoption? Let us see?

The dividing of the work in the architect's office and the likelihood of delay growing out of doing so seems tangible enough to those who have believed in it, and who have had little or no experience to disprove the notion. I remember one case in which the owner arranged for an outside engineer to do the work, but the architects were so sure that it was an impossible arrangement that they spent some hundreds of dollars duplicating the work of the engineer before they were convinced that it was unnecessary. As a matter of fact, the very opposite is true. The dividing of the work is more likely to give point and snap to the work remaining to be done in the architect's office, than otherwise. It is hard to make [illegible] doubting believe, but more than one member of the [illegible] stitute has borne testimony to such an experience.

No consulting engineer can preserve his independence [illegible] business unless he can find a way of doing his work [illegible] little or no trouble to his client and also unless he [illegible] do it quickly, making every figure and every line [illegible] in the final result. He cannot afford to have the [illegible] drag in his office, nor to speculate with uncertain [illegible] He wants to get things settled. So does the architect, [illegible] but the architect can be put off. The engineer, however, [illegible] objects to doing work until things are settled. So [illegible] ions are hastened, and both the architect and the [illegible] neer get the benefit. Many times, also, the touch of [illegible] two offices with each other is like an infusion of [illegible] blood to the slower one. Sometimes it is to keep ahead [illegible] the engineer, just a matter of rivalry; and at other times [illegible] it is to keep him informed regarding the general [illegible] struction. This particular difficulty, therefore, can also [illegible] be overcome if the work is rightly managed.

The cost of the work, as already stated, has been the hardest difficulty to satisfactorily adjust. It has prevented the employment of the engineer more than anything else. If the cost of his services could always be obtained from the owner without encroachment upon the architect's regular fees, it would undoubtedly do much to simplify the problem. But the general acceptance of such an arrangement in the immediate future can not be hoped for. From all reports, it is often difficult to obtain the regular commission, and any charges in excess of such cases are impossible. If any general effort could be made by the architects or by the engineers, or by both professions co-operating, to definitely establish this relation between the two professions, and it was predicted upon the willingness of the public to pay the extra commission, the movement would probably come to nothing. The public are educated slowly, and for a good while at least, their willingness to pay the additional commission would be the exception. In the meantime, other influences are gathering headway, and they in turn, would probably prevent the success of such an effort in the more distant future. The conditions are such, it seems to the writer, that such an undertaking should be made, if at all, upon some basis which can be put in operation in a comparatively short time, and which does not require the co-operation of the public. This does not mean that an extra commission from the owner is undesirable. It is desirable, and every effort, both of the architect and the engineer, should be put forth to secure it. It is probably a fact that the amount of work required of the architect in these days, in proportion to his income, is greater than it used to be, and that this additional compensation, if it may be called such, would not make the architect much, if any, better off, than he would have been with the same amount of work a few years ago. It is also true that some owners have already paid this additional compensation and that some others can be easily induced to pay it; yet, notwithstanding these points to the contrary, it is important that the success of the movement should not be dependent upon the willingness of the public to pay the extra commission.

It seems to the writer that the following points should be made with reference to this question of the engineer's compensation: (1) It should be paid by the architect. (2) It should be adequate. (3) An extra commission on account of this expense should be obtained from the owner, if possible. (4) The compensation should be a commission. (5) If an extra commission can be obtained from the owner, the engineer should get the benefit of it. (6) If the extra compensation can not be obtained from the owner, the engineer should be content with a smaller commission. (7) The commission should be the same for all kinds of engineering pertaining to building work, structural as well as mechanical, and (8) the commission should cover only the work included in the service.

The engineer's compensation should be paid by the architect, because that is most in keeping with the subordinate relation of the engineer. It puts into the architect's hand without friction and without question the power to retain his management of the business.

The compensation should be adequate, otherwise the whole idea of establishing a permanent and satisfactory relation between the two professions will fall to pieces. The engineer will more and more assert himself, and he will not agree to any fixed relations unless it provides for a full and adequate compensation for his services.

If an additional commission is paid by the owner, the engineer should give something for it, otherwise it will be difficult to persuade the owner that the additional compensation is necessary. It is suggested that the engineer should assume the full responsibility of the architect in reference to his part of the work when he receives the full commission; that is, the full compensation which he should receive when an additional commission is obtained from the owner; and, on the contrary, that he should not be held any more responsible than an employee of the architect's office, if this full compensation is not paid. This will be to the advantage of both the architect and the owner. It will tend to prevent the employment of incompetent men as consulting engineers; it will encourage the employment of better employees in the engineer's office, and will promote better work in every way.

The engineer will undoubtedly be more careful with

his work if he faces the possibility of losing his commission when it is not promptly done. Mathematical computations will be more perfectly checked, plans and specifications will be more thoroughly studied, and the placing of the responsibility on the engineer in a definite way can not fail to bring about a better service. This is really the same argument that we are now presenting to the owner when we tell him that he can have an engineer's services if he pays for them; for, under present conditions, the architect is bound to furnish the owner something in the way of technical work, whether an extra compensation is paid or not.

And this compensation should be a commission, though a number of the leading engineers of the country undoubtedly prefer a fixed sum. Many of the architects are also accustomed to paying a fixed sum instead of a commission, but nothwithstanding these preferences, it is the writer's opinion that in all ordinary cases it should be a commission. If any arrangement is made to establish a definite and fixed relation between the two professions, it must unquestionably cover the problem of compensation, and that can be stated in the terms of a commission definitely, equitably, and generally, while it can not be stated in any general terms on the basis of a fixed sum. Moreover, such a plan can be carried out and the adequate compensation of the engineer can be maintained in that way with the least friction. It also enables the architect to compare the amount he pays out with that which he receives, which he can not readily do if the engineer's compensation is fixed in any other way.

In any case the architect ought not to be obliged to pay out all that he receives. It is right that the engineer should be adequately paid, but it is also right that the should be a fair division. If it is worth while to undertake to establish a fixed relation between the two professions, which can be maintained whether the public falls into line or not, and the architect is to employ the engineer, whether he receives the extra commission or not, the engineer should be expected to serve in any case and to receive a less compensation if necessary.

In order to give point to this suggestion with reference to compensation, the writer would suggest the following rule to cover all ordinary work: Charge the owner 7½% commission for all technical work for which engineers are required. If the 7½% is obtained from the owner, pay the engineer 5% when superintendence is included in his services, and 3½% when it is not. If only 5% commission is obtained from the owner, pay the engineer 3½% when superintendence is included in his services and 2½% when it is not. The cost of the engineer's services for extraordinary work, under this rule, would have to be adjusted in each individual case, and the question of whether work was ordinary or not would have to be determined before the work was begun. The rates named in the rule would not be sufficient to cover all cases. Often the actual cost of designing the structural steel work for a theater, without superintendence, is 5%, or more. Let us turn now to the other query: Has the relation advantages of sufficient importance to warrant changing other methods we have been using in order to secure its adoption. It seems to the writer that it has. There are perhaps 25 or more engineers of large experience in the several departments of building construction, now in independent practice in different parts of the United States, and the most eminent and the most capable men in the world in these departments of work are to be found in this number. The monied interests of the country are awakening to a greater conception of the importance of good structural and mechanical designing, and more and more, in the future, they are going to require tecnnical services of a high order. They will eventually force the situation. Unless some arrangement is made for co-operation, most of these engineers will, sooner or later, be employed by the interests that now employ the architects, and the more this is done the more difficult it is going to be to standardize the relation of architect and engineer. In this same connection it should not be forgotten that the schools of our country are turning out well-trained young men in the engineering profession, several thousands of them each year, a considerable part of whom are going into building work. An evolution is in progress. Shall we drift with the current, or shall we control it? It would seem to be better to fashion events and not let them fashion us. It would seem better to yield a little here and a little there of our individual preferences, in order to secure the common good. It would seem to be better, possibly, to sacrifice something at the present time, if thereby a reasonable relation between the two professions may be fixed and maintained.

In this day of the centralization of power and responsibility the best interests of the owner are unquestionably subserved by making one man responsible, and only one. I confidently believe that no practice can become uniformly acceptable; no relations between architects and engineers can ever give satisfaction, that is not founded upon this fundamental idea—the centralization of responsibility in one man. If this is true, engineers should not hesitate to accept a position of subordinate service, for it may be reasonably contended that the architect is the one man that should be in this position of supreme control. Not only is precedent in his favor, but the character of his work and the wide range of its requirements especially fits him for this larger responsibility. In this new dispensation, whatever else he is, he must be a man of affairs in the architectural world, and the engineer can not take that place of responsibility, however well qualified he may be for doing so, without subordinating his technical work to the larger demands of such management.

On the other hand, the architects should not fail to appreciate the changing conditions. They should not hesitate to meet the engineer half way. They want only reasonable profits for their labor, an undivided responsibility in their own departments, and the credit which is due to them for really worthy achievement. Less than this, they will not be content with.

The architect in full control of the planning and execution of every great architectural undertaking, retaining structural and mechanical engineers who have their own independent practice, and sharing with them the emoluments and the honors of their achievements; the engineers laboring independently within his own province, without limitations, except by the financial and architectural conditions of his problems, receiving adequate compensation while he maintains the position of the architect; such is the ideal relationship of architect and engineer, and particularly so if both individuals are broad-minded and reasonable, and over all, there be mutual sympathy.

Let us summarize the points we have made in relation to it: (1) It is open to no insurmountable objections. (2) The details of its operation can be arranged in all cases so as to offer no serious disadvantage. (3) It can be made to afford the engineer a regular and adequate compensation. (4) It conserves the best interests of all concerned, by fixing the responsibility and the managing control for each undertaking on one man. (5) It provides that the architect shall be that one man, and would undoubtedly perpetuate that arrangement. (6) It insures the best results, making it possible for any architect to avail himself of the best technical service the country affords, and (7) it enables the architect to place a definite responsibility for the technical work upon those whom he calls to his assistance.

Only one thing more remains to be said: Certain things must be done if we would undertake to establish such a relation: (1) It must be deliberately worked for. It will not "come drifting." (2) It must be a co-operative effort. (3) It must be a general effort. (4) It must be undertaken in a spirit of compromise and good will.

If a committee were appointed by the American Institute of Architects to consider this matter and to confer with the engineers, the latter would undoubtedly find some acceptable way of meeting them. There is certainly a great deal of dissatisfaction with present conditions, and a number of the leading engineers have already expressed their wish that some action might be taken to put the relation of the architects and engineers upon a better basis. Any such effort will come to naught, however, unless it is undertaken in a spirit of compromise and good will. There must be, on the part of the engineers, a willingness to take a subordinate part, and to support the architects in maintaining that relation, even though sometimes it may require an apparent sacrifice; and there must be, upon the part of the architects, a willingness to share in both their compensation and in the credit of their achievements.

FIRST ANNUAL MEETING OF THE WOOD PRESERVERS' ASSOCIATION.

The Wood Preservers' Association, a new society formed at a meeting of men interested in timber preservation, at St. Louis, Mo., October, 1904, held its first annual meeting at New Orleans, La., on Jan. 17 to 19, 1905. About a dozen members were present. A constitution was adopted, several papers and reports were read, and the plans already laid to advance the art of timber preservation were somewhat elaborated.

Headquarters were at the St. Charles Hotel, and five sessions were held. The proceedings are briefly abstracted in the following.

DETERMINATION OF CHLORIDE OF ZINC.

The Committee on Tests for Zinc Chloride reported the following method:

Principle.—The chloride is determined by titration with standard silver nitrate solution, and then calculated into zinc chloride.

Solution.—Tenth-normal silver nitrate solution; 16.996 grams pure acid-free silver nitrate are dissolved in 1 liter of distilled water.

Indication.—Neutral potassium chromate, K_2CrO_4 (Chlorine-free); saturated solution.

Method of Procedure.—5 c. c. of the zinc chloride solution are introduced into an Erlenmeyer flask, diluted to 100 c. c. with cold water and 2 drops of indicator are added. The standard silver nitrate solution is now run in from a burette until the solution in the flask just begins to assume a reddish tinge, the flask having been shaken during the whole operation.

Multiply the number of c. c. of silver nitrate consumed by the factor .680, and divide this product by the product obtained by multiplying the number c. c. of zinc chloride solution taken by the specific gravity of the zinc solution, or expressed as a formula:

$$\frac{\text{c. c. silver nitrate} \times 0.68}{\text{c. c. zinc chloride} \times \text{Sp. gr.}} = \% \text{ zinc chloride.}$$

This method, depending upon the determination of chlorine, is vitiated in accuracy by the presence of any other chlorides. It is therefore necessary to see that the water used for dissolving the zinc chloride is free from chlorides, and the determination does not detect adulteration by other chlorides, as common salt. A communication from the laboratory of the Union Pacific Preserving Works described a method of determining by the zinc, as follows:

Sampling.—A fair, average sample must be taken from one out of ten drums. The sample must be quickly transferred to a clean, dry, salt-mouthed bottle, stoppered, hermetically sealed, and taken to the laboratory for testing. The sample should be numbered with a number or other device, corresponding to the drum or the lot from which it is taken.

FIRST METHOD.

Basic Zinc Chloride.—Pulverize about 10 grams of fused zinc chloride by crushing between filter papers; quickly transfer to a weighing bottle. This operation must be performed quickly, owing to the deliquescent nature of the substance. Weigh the bottle plus the sample, transfer the same to 500 c. c. of water in a beaker, and weigh the bottle again. The weight of the sample is thus obtained by difference. Cover the beaker and allow the solution to stand for twelve hours. Filter through a weighed Gooch crucible into a liter flask. Wash the residue with cold water until it is free from chloride. Dry the basic chloride at 100° C. for twelve hours, and weigh.

Dilute the filtrate to 1,000 c. c.

Soluble Iron.—Take 50 c. c. of the filtrate, boil, and precipitate with ammonium hydroxide. Filter on an ashless filter paper, wash three to four times in hot water, and set the filtrate aside. Dissolve the filtrate off the paper with hot, dilute hydrochloric acid, and reprecipitate with ammonium hydroxide. Filter through the original paper, receiving the filtrate with the first filtrate. Wash the ferric hydroxide five or six times with hot water, ignite and weigh as Fe_2O_3.

Factor for metallic iron	.7
Factor for Ferric Chloride	1.0156

Soluble Zinc.—Add to the filtrate from the iron a concentrated solution of sodium carbonate, until it is slightly alkaline. Zinc is precipitated as basic carbonate. Boil fifteen minutes. Decant through a weighed Gooch crucible and wash by decantation three or four times. Ignite at a high temperature and weigh as ZnO.

Factor for metallic zinc	.8034
Factor for Zinc Chloride	1.6744

Soluble Chlorine.—Titrate 25 c. c. of the solution with decinormal solution of silver nitrate.

Free Acid.—Dissolve 10 grams of the fused zinc chloride in 100 c. c. of distilled water and test with methol orange.

Calculations.—Soluble zinc is to be calculated as soluble zinc chlorine, provided there is insufficient soluble chlorine present to combine with the zinc, after subtracting the chlorine equivalent to the free acid and also to the soluble iron, as ferric chlorine.

SECOND METHOD.

About 10 grams of powdered zinc chloride (powdering to be done between filter papers) is weighed in a weighing bottle. The greatest care must be taken that the fused chloride is not exposed to the air longer than is absolutely necessary on account of it taking up moisture. The weighed fused chloride is then dissolved in one-half liter of water and left to stand for twelve hours, then, after it has settled, filter through a weighed filter into a liter flask; the residue is washed with cold water until the wash water is free from chlorine, and the filtrate and wash waters diluted to 1,000 c. c. The filter is then dried in a hot oven at 100° C. for at least twelve hours, and then weighed again. In this way the basic chloride of zinc is found.

Fifty cubic centimeters of the filtrate are tested for soluble zinc by precipitating it with sodium carbonate and weighed as zinc oxide, correction to be made for impurities, if any. The soluble zinc, after corrections for impurities, shall be calculated as soluble chlorine, provided the analysis for soluble chlorine shows a sufficient amount to combine with the soluble zinc found. Soluble zinc is found by the following method: 25 c. c. of the filtrate is tested for chlorine (soluble) by titration with silver nitrate solution, indicator K_2CrO_4, corrections to be made for other chlorine of other metals present, if any.

Free acid is found by dissolving a few grams of the sample in at least ten times as much water, by adding methyl orange. The presence of acid can readily be observed by the usual reaction.

Iron is found by basic precipitation with ammonia, redissolving and re-precipitation. A trace of the iron is considered .022 Fe.

It was voted that further information is to be gathered on this subject, and in the meantime no action taken to adopt a standard method.

TESTING CREOSOTE.

On the subject of testing creosote oils, a paper was submitted by Mr. H. W. Jayne, of the Barrett Mfg. Co., Philadelphia, Pa., summarizing recent studies of creosote tests in the laboratories of that company. These studies are held to show that, while one operator using the same oil in the same apparatus can repeat tests and obtain very close figures, yet in general creosote tests are subject to great variations in results. The size of the retort is of much influence. If a four-ounce retort be used for 100 g. of oil, as often required, then to prevent boiling over the distillation must be so slow that much larger portions distill at low temperatures than would appear in a larger retort. This is shown in the following results, obtained from the same oil by the same operator with three different retorts:

PER CENT. DISTILLED UP TO VARIOUS TEMPERATURES.

Listed Size of Retort	4 oz.	8 oz.	8 oz.
Actual Capacity of Retort ...	5 oz.	10 oz.	13½ oz.
To 170° C.	13.5	0.6	0.2
200° C.	56.5	10.5	5.6
210° C.	65.3	26.0	17.6
235° C.	83.6	58.2	53.2
315° C.	95.7	87.5	85.5

The results may be affected by the distance of the thermometer from the surface of the liquid. The bulb should be one-half inch from the surface; if it is closer, the indicated temperature will be that of the liquid spray, i. e., higher than that of the vapor. Thermometers filled with nitrogen gas should be used, if accurate indications above 300°C. are required.

In the matter of specification requirements, the paper says:

Among the many specifications submitted to this laboratory, some are found to contain clauses which are contradictory. For instance, then, an oil must have a heavy gravity, and yet 90% must distill below 315° C. As these heavy oils owe their gravity to high boiling bodies, like anthracene, which boils above 300° C., the higher the gravity the more there will remain undistilled above 315° C.—always more than 10%.

Specifications taking into account tar acids are now used less frequently than heretofore. Nevertheless, at times oils are asked for which shall have a heavy gravity, and at the same time contain a considerable amount of acids. The amount of these acids present in the oil depends on the kind of coal, and the temperature used to produce the tar; and is therefore beyond the control of the distiller; but in any oil the acids are present in largest amount in the portions around 200° C., and decrease gradually as the temperature rises, until at about 300° C. no acids are present. Therefore, high boiling oils of heavy gravity cannot contain large amounts of acids.

The following correction coefficient is suggested for reducing determinations of specific gravity to the same temperature, 15°C. or 60°F.: If the determination was made at temperature (15 + T)°C. or (60 + t)°F., add to the observed specific gravity the amount 0.0008 T or 0.00044 t, respectively.

The complete solubility of a sample of creosote in benzine or absolute alcohol is found to be no assurance of freedom from adulteration by oils made from oil or water gas tar. In fact, pure coal tar oils, when containing much anthracene, require far greater quantities of solvent than adulterated oils.

It is recommended in the paper that in all values to be found by distillation, a range of 5% be allowed for unavoidable variations in testing.

On motion, the Committee on Creosote was reinforced by adding three chemists, Messrs. E. Christian, A. W. Powers, and N. F. Harriman were appointed.

CREOSOTED TRESTLE TIMBER.

A paper was read by Mr. J. C. Haugh on "Twenty-five Years' Experience with Creosoted Timber and Results," which follows in slightly condensed form:

An experience of twenty-three years in the maintenance of creosoted pile trestles shows that both close-grained long leaf yellow pine and the grades known as short leaf, loblolly, etc., can be preserved for a period of thirty to forty years. This is demonstrated by sections of piles and stringers treated in 1883, and that were recently removed from the structures. The treatment was according to the specifications of the Pascagoula Works, both as to quality of oil used, seasoning, etc. The amount of oil called for was 15 lbs. per cu. ft. The life of the sap wood on the piles, if untreated, would have been but about two years, and it is now sound. The life of the heart wood of the piles might have been six or eight years, if untreated, and it is now sound. The coarse-grained pine stringers in this case would hardly have been worth putting into the structure if in their natural state, so short would have been the life of this timber. They are now sound and of about the original strength. Specimens of sawed cross ties and plank which have been in use for about twenty-two years and are still sound can also be furnished.

It is well understood that all framing and boring of timber should be done before treatment. Where any cutting is done after treatment, the cut surface should be thoroughly saturated with hot creosote oil, and asphalt thinned with creosote oil applied. Heads of piles have necessarily to be cut off after driving, and this exposes the heart wood, into which the creosote oil has not penetrated; the result will be decay of the heart wood, unless the head of the piles have hot creosote oil applied and afterwards a coat of hot asphalt thinned with creosote oil. Any projection of the sides of the piles beyond the face of the cap should be neatly adzed off, and the same treatment applied as to other cut surfaces.

Pine caps of 12 × 12 ins. and larger are subject to serious "checking," which admits water to the uncreosoted heart wood, and decay results. To overcome this, I would recommend that all timbers 12 × 12 ins. and over, exposed to the sun and weather, as caps are, be bored through the center from end to end with a 1-in. auger before treating. This hole will largely prevent checking in untreated and treated timber, and will enable the seasoning to be better accomplished, as well as permitting creosote oil to penetrate the heart wood more thoroughly. The hole can be pegged at each end and water be prevented from entering. Creosoted caps could also be built up from, say, 3-in. or 4-in. planks.

It is very important that all timbers, like cross ties, should be either halved or quartered, and the heart side turned down. The pine pole ties treated thoroughly will in a few years "check," so that water will enter the heart wood and cause decay in the middle, leaving a sound shell of creosoted wood. The quartered and halved ties and guard rails with heart turned up are subject to the same checking and resulting decay, but if the position is reversed, checking beyond the creosoted wood does not occur as much. The same remarks will apply to planks.

The seasoning of the timber to be treated should be considered as the most important, afterwards the injection of the creosote oil, then the proper placing of timbers and protection of all cut surfaces. It is my opinion that timber that was cut in the winter months, and timber cut from logs that have lain in the water for some months, will give the best results in seasoning and durability.

SEASONING TIMBER.

A short paper on Seasoning and the Use of Saturated Steam was presented by Mr. F. D. Beal of West Oakland, Cal. The following are some extracts from the paper:

In the burnettizing process, when green material is used for treatment, it is necessary to season artificially in order to prepare it for the injection of zinc solution. I found, in my experience, that the manner of seasoning had to be varied greatly, according to the character of the timber. On some classes of material, I advocate air seasoning; on others I do not.

On the Pacific Coast we have a sap pine which we term "Shasta Sap Pine," running 75 to 90% sap wood. On this class of material, I think it would be policy to thoroughly air-season before treatment, as this class of material, when green, contains a large percentage of sap water and wood liquids; also a large percentage of resinous, pitchy matter. By air-seasoning, a large amount of this liquid would be eliminated, which would shorten the process of treatment to a large extent.

But I think the process of seasoning should be carried further after the material has been placed in the cylinder, if for no other purpose than expelling the air in open cells, which would act as a resisting force against the injection of the preserving fluid. This, of course, can be accomplished by applying saturated steam, heating the timber thoroughly throughout, forcing all air out, and any liquid remaining in the wood which would act as food for any destructive fungi; also killing all diseases peculiar to tree life.

On the Pacific Coast we have occasion to treat with the burnettizing process a large amount of Oregon red fir ties, which you all know to be a firm, close-grained wood. On this class of material we obtain much better results by treating in the green state. In allowing these ties to air-season, the resinous matter becomes congealed, and so hard that we find difficulty in dissolving this matter in order to allow our solution to penetrate readily. To do it, the steaming has to be carried to such an extreme that, as a result, the material is practically burned up and worthless. We found that we obtained much better results by treating these ties green; steaming them for three to four hours, and not allowing the temperature to exceed 280° F., thus eliminating the resinous matter (which is, to a certain extent, in liquid form while the wood is green) much easier than if it had been allowed to harden by air-seasoning.

Good results are being obtained by using the steaming process, especially on the more open-grained, spongy woods; but, in treating the denser woods, such as Oregon pine, red fir, etc., the steaming proposition has proven to be a complete failure when it is applied to large dimension timber and piling, in the creosoting process. On account of having to be carried to such an extreme in order to thoroughly sterilize and remove the sap moisture, and other destructive matter in the wood, the strength of the material was so reduced that it was practically worthless.

There are a great many concerns using the steaming and vacuum process on these denser woods, by using a limited amount of steam and then injecting the preservative. When applied in this manner, good, lasting results will never be obtained, for the moisture and destructive agents contained in the wood have not been removed, and the consequence is, that the center of the material decays, leaving an outer shell of treated wood, the thickness of the depth to which creosote oil or other preservative liquid has penetrated.

It has been found by long experience in treating these denser woods that most perfect results are obtained by carrying on seasoning similar to Boulton's method of boiling the timber or piling in creosote oil, and improvement being made in the process by cutting out the operation of a vacuum pump and simply allowing the vapor to come off of its own accord, discharging into a surface condenser, through which cold water is circulated, thus creating its own vacuum by the elimination of sap and moisture contained in the timber. In this manner, by carrying a lower temperature, say 212° to 220° Fahr., all the moisture can be extracted, the wood thoroughly sterilized throughout, and one of the most important features of all, the exact dryness of the material, can be ascertained by the amount of condensation collected in the hot well of the condenser, as all condensation collected represents moisture from the wood alone, and is not mixed with condensed steam, which would be the case when saturated steam was used in seasoning. The length of time required is no greater than when treating with a steaming process, and on some classes of material the time of treatment runs considerably less.

There is one important feature in connection with seasoning timber in the above manner; in instances where close-grained, firm, hard woods are what we term "water-seasoned," that is, the natural sap and moisture has been displaced by water absorbed on account of piling lying in the water in rafts for a long period. Ordinarily it takes a long time to extract this water, especially when piles run in large diameters. I have treated some of this class of material when the time of extracting the water alone was 75 hours on a single charge. After remaining in this condition for so long a time, one would naturally suppose that the life would be taken completely out of the wood; but quite to the contrary is the case. The piles come out in perfect condition, with hardly a sign of checking or cracking in any manner, and with nearly as much life and elasticity in the wood as before treatment.

A paper by Mr. E. S. Christian on "Heating Coils, Doors, Flanges and Valves," presented several recommendations for the care of these details. As the best packing for doors the author recommends asbestos rope coated on the door side with black oil and graphite. Flange gaskets are packed with a similar rope having copper threads interwoven; the same lubricant as above is used.

Mr. P. F. Dundon of Seattle, Wash., read a paper in which he recommended that steps be taken by the association to collect and diffuse correct information on treated timber and its service. Three committees were, in consequence, appointed for this purpose, to handle the respective subjects Creosoting, Paving Blocks, and Burnettizing.

The constitution adopted by the association provides for two grades of members, Corporate and Associate, the former including only executive or technical officers of timber preserving plants. The annual dues for both classes are $10.

It was decided to hold the next meeting of the association at Chicago, Ill., beginning Jan. 19, 1906. Mr. P. R. Smith of the Ayer-Lord Tie Preserving Co., Chicago, is chairman of the Committee on Arrangements, and Mr. E. S. Christian, Norfolk, Va., is chairman of the Program Committee for this meeting. Mr. C. W. Berry, Laramie, Wyo., is secretary of the association.

A CONFERENCE OF HYDROGRAPHERS of the U. S Geological Survey engaged in stream gagings east of the Mississippi River was held at Washington, Jan. 3 to 12, 1905. Among the 15 leading topics discussed were the following: Winter Records for Current Meter Gaging Stations; Gages; The Maintenance of Permanent River Stations; Effect of Grass on Stream Gagings; Curves of Mean Velocity and Area; Methods of Counting Seconds and Revolutions in Making Low Water Measurements; Equipment of Cable Stations; Cost of Stream Gaging; Evaporation. The men in charge of the five districts represented at the conference are as follows: New England: H. K. Barrows, Engineer-in-Charge. New York and Michigan: R. E. Horton, Hydrographer-in-Charge. New Jersey, Pennsylvania, Maryland, Virginia and West Virginia: N. C. Grover, Engineer-in-Charge. Southern States: M. R. Hall, Hydrographer-in-Charge. Eastern Mississippi Valley: E. Johnson, Jr., Engineer-in-Charge.

RAILROAD TRAIN ACCIDENTS in the three months ending Sept. 30 last, caused more casualties to passengers than in any quarter year since official statistics were collected. There were 228 passengers and 183 employees killed, and 2,154 passengers and 1,593 employees injured, making in all 411 persons killed and 3,747 injured in train accidents.

The total number of collisions and derailments was 2,760 (1,439 collisions and 1,321 derailments), of which 232 collisions and 137 derailments affected passenger trains. The damage to cars, engines and roadway by these accidents amounted to $2,439,073.

Of the total number of 228 passengers and 183 employees killed in train accidents, 217 cases (nearly all of whom were passengers) were accounted for by two derailments and four collisions.

A VACUUM CLEANING SYSTEM, recently patented, is being commercially exploited in New York City. Its advantage over the compressed air cleaning system now in extended use is that the dust is drawn *into* the cleaning nozzle and so removed from the apartment instead of being stirred up and spread broadcast as with compressed air. A very large vacuum plant for car-cleaning has just been erected in the yards of the Central R. R. of New Jersey at Jersey City. The piping covers a yard 3,600 ft. long and about 3 miles of pipe, 2 ins. to 5 ins., diameter has been laid. Taps are connected to these mains at short intervals and flexible hose is run from these cocks, entering the cars through a door or window. At the foot of the hose is a metal pipe, with a flat triangular end, along the base of which is an opening, through which the dust and dirt is drawn. The operator runs the slot opening over the cushions, carpets, curtains, woodwork, etc., and every loose particle of dust is whisked away. The air removed, before reaching the central vacuum pump passes through two dust separators, the first of which clears the air of 90% of the grit and dust; the second separator draws the air through water in which corrosive sublimate is used, and completes perfectly the purification.

A COLUMBIAN LONG SPAN FLOOR for the new warehouse of the Long Island Storage Co. was recently subjected to a load test of 750 lbs. per square foot without injury. The warehouse is 125 × 120 ft. in plan and nine stories high. Columns spaced 15 ft. apart one way and about 11 ft. apart the other way carry I-beam girders launched around with concrete and carrying on thin top flanges a 5-in. concrete slab reinforced with 3½-in. Columbian bars spaced 2 ft. apart. Two wall bays of this floor were loaded with bags of cement until the load reached 750 lbs. per square foot. The floor was designed for a load of 120 lbs. per square foot with a factor of safety of four.

DAMAGES AND COSTS AMOUNTING TO $25,000 have been awarded against the city of New York, and affirmed by the Appellate Court on account of the death of an engineer and fireman due to an explosion at the Long Island City water-works pumping station in November, 1902. The court held that the city had evidence in its possession to the effect that the boiler feed water was highly charged with chlorine but failed to protect or warn its servants at the pumping station against the consequent unusual dangers from corrosion of the boilers.

SINKING A SHAFT BY THE FREEZING PROCESS is described in an interesting article in "The Iron and Coal Trades Review," Jan. 13, 1905. The work was done at the Auguste Victoria Colliery, near Recklinghausen (Westphalia). The experience gained during the work of freezing is summarized as follows by the author: Before attempting to freeze a similarly flooded shaft it is advisable to fill it up with sand, since wet sand is more easily frozen than water, and offers greater resistance than ice alone. At the same time, the sand retards the flow of water from outside, and enables the freezing pipes to be set in a larger circle around the shaft. The distributing and collecting rings for the brine should not be placed too near the ground water level, or, as happened in the present case, water may enter from above the wall of ice. Alterations in the water level around the shaft should be avoided as much as possible, no underground pumps being kept at work in the immediate vicinity, since the circulation they produce retards the formation of the wall of ice.

PERSONAL.

Mr. E. D. Rich has been reappointed City Engineer of Summit, N. J.

Mr. J. B. Weddell has been reappointed City Engineer of Olympia, Wash.

Mr. John Strother, Chief Engineer of the Consolidation Coal Co., with offices at Frostburg, Md., has resigned to accept a position with a Southern railroad.

Mr. J. Rivers Carter, M. Am. Soc. C. E., has been appointed Postmaster of Birmingham, Ala. Mr. Carter was City Engineer of Birmingham from 1884 to 1891.

Mr. Van Alen Harris, M. Am. Soc. C. E., formerly of Giles & Harris, Consulting Engineers, San Juan, Porto Rico, has opened an office at 17 State St., New

Mr. Charles Pearson has been appointed Chief Assistant Engineer of the Atlantic & North Carolina R. R., with headquarters at New Bern, N. C., to succeed Mr. J. E. Read, resigned.

Mr. Joseph R. Focht has resigned his position with the Anaconda Copper Mining Co., to accept the position of Constructing Engineer for the United States Mining Co., at Salt Lake City, Utah.

Mr. W. O. Gleason, Superintendent of Harbors and Wharves, of Cleveland, O., has been promoted to the position of Engineer in Charge of Sewer and Water House Connection Department of that city.

Mr. Alfred L. Maggi has been reappointed City Engineer, Superintendent of Streets and Harbor Master of Chelsea, Mass. Mr. Harry H. Clifford was appointed City Electrician and Superintendent of Wires of that city.

Mr. Edwin J. Pickwick and Miss Bertha E. Fish were married Jan. 18 at Worcester, Mass. Mr. Pickwick is a civil engineer, and at present is engaged on the construction of the metropolitan water basin at West Boylston, Mass.

Mr. J. L. Ludlow, M. Am. Soc. C. E., of Winston-Salem, N. C., has been appointed Chief of Engineers of the State Guard of North Carolina. Mr. Ludlow will have the rank of Colonel on the Military Staff of Governor Glean.

Mr. G. W. Vaughan, Division Engineer of the New York Central and Hudson River R. R., with headquarters at Buffalo, N. Y., who has been critically ill with pneumonia, has gone to Florida with the hope of expediting his recovery.

Mr. F. H. Bainbridge, Engineer of Bridges of the Illinois Central R. R., has been appointed Principal Assistant Engineer of the Chicago & Northwestern Ry., succeeding Mr. W. H. Finley, who has resigned to take up a contracting business.

Prof. William H. Burr, M. Am. Soc. C. E., and Mr. William Barclay Parsons, M. Am. Soc. C. E., members of the Isthmian Canal Commission, have sailed for Panama, to make an inspection of the Canal work now being done on the Isthmus.

Mr. Winslow M. Mead, of Rochester, N. Y., has been reappointed Deputy Superintendent of Public Works of the State of New York. Mr. Mead served as Deputy under Superintendents Boyd and Partridge, and was Chief Clerk under Superintendent Aldridge.

Mr. William R. King, M. E., formerly of 39 Cortlandt St., New York, has become associated with Sanderson & Porter, 52 William St., New York, in their general practice as consulting engineers and contractors for the development of railway, light, hydraulic and power propositions.

Mr. Walter McCulloh, M. Am. Soc. C. E., has retired from the position of City Engineer of Niagara Falls, N. Y., his term of office having expired, and will henceforth devote more of his time to his private engineering practice. Mr. McCulloh was City Engineer from April, 1902, to the present time.

Mr. S. Kedzie Smith has been appointed General Superintendent of the Utah Fuel Co., with headquarters at Castle Gate, Utah. This company operates one coal mine in Colorado, and four mines, with 500 coke ovens, in Utah. Mr. Smith was graduated from Rensselaer Polytechnic Institute in the class of 1886.

Mr. Walter Buehler has resigned as Assistant City Engineer of Indianapolis, Ind., and will go to Minneapolis, Minn., to take charge of the creosoting plant of the Kettle River Quarry Co. Mr. Buehler has had charge of the municipal testing laboratory of Indianapolis since its establishment. He is a graduate of Purdue University.

Mr. Claire M. Belding, Assistant Engineer in the Paving Department of Cleveland, O., has been promoted to the position of Engineer in Charge of Harbors and Wharves, to succeed Mr. J. W. Sturtevant. Mr. William Mahon, Second Assistant Engineer in the Paving Department, was appointed Assistant Engineer, to succeed Mr. Belding.

Mr. John J. Sullivan has severed his connection with the Holyoke Valve & Hydrant Co., as Superintendent of Construction, and henceforth will devote his attention to the firm of Kennedy & Sullivan, Holyoke, Mass. Mr. Sullivan is succeeded by Mr. George B. Oliver, who formerly was associated with the Carmen-Thompson Co., of Lewiston, Me.

Mr. Alfred Craven, M. Am. Soc. C. E., has been appointed Acting Deputy Chief Engineer of the New York Rapid Transit Commission. Mr. Craven is a graduate of the U. S. Naval Academy, but resigned, and for some years he was one of the engineers of the new Croton Aqueduct. In 1900 he was made Division Engineer of the 2d Division of the Rapid Transit Commission.

Mr. Edward Van Winkle has removed his offices to the Flatiron Building, Broadway, Fifth Ave., and 23d St., New York, where he will continue the engineering business of Pratt & Van Winkle, formerly of 160 Fifth Ave. Mr. Chas. R. Pratt, who was formerly associated with Mr. Van Winkle, has retired from that firm, and is now devoting his entire time to the interests of the Elevator Safety Co., which bears his name.

Obituary.

Frank Wells, for the past twelve years President of the State Board of Health of Michigan, died recently.

John Herbert Walker, Chief Engineer of the Water-Works Department of Pawtucket, R. I., died Jan. 12 at his home in that city, aged 57 years.

George S. Coutant, one of the pioneers of the cement industry in Ulster County, New York, died Jan. 23, at Kingston, N. Y. He was 77 years old.

James Hughes, who died Jan. 13 at Toronto, Ont., was formerly a civil engineer, one of the most notable of his achievements being the laying out of Parkhurst Barracks Square, Isle of Wight.

Charles D. Vassar, a master mason, noted for his construction of high chimneys, died Jan. 19 at his home in Brooklyn, N. Y. Mr. Vassar was born in Norfolk, England, 69 years ago, but came to this country when a boy and learned his trade here. He was with the firm of George Vassar Sons for 45 years.

Charles Ehlers, Superintendent of the Bureau of Engineering and Surveys, of Allegheny, Pa., died Jan. 17 at the Presbyterian Hospital in Pittsburg, Pa., as the result of an operation. Mr. Ehlers was born in Mecklenburg, Germany, in 1839, and in 1872 he came to Allegheny, entering the employ of the city under Chief Engineer Charles Davis. In 1879 he succeeded Nathan McDowell as Chief Engineer.

Henri J. Scheltgen, a sculptor, and especially well known as a designer of architectural decorations, committed suicide last week at his home in New York City, by cutting his throat with a steel modeling knife. Mental aberration, due to continual pain for the last two weeks, is supposed to be responsible for his act. Mr. Scheltgen was born in France, but had been in this country for 22 years. He made the model from the architect's design for the Soldiers' and Sailors' Monument in Riverside Park, New York. He was 55 years old.

William Barnet Le Van, one of the older mechanical and consulting engineers of this country, died at Newark, N. J., on Jan. 7. Mr. Le Van was of Huguenot stock, and was born in Easton, Pa., in 1829. He lived for many years in Philadelphia; was an authority on steam and steam boilers, and wrote several books on these subjects. He put in the first hydraulic lift erected in Philadelphia. Mr. Le Van was one of the oldest members of the American Society of Mechanical Engineers, and was a life member of the Franklin Institute of Philadelphia.

Edward Sherman Gould, M. Am. Soc. C. E., died at the Hotel Aldine, New York City, Jan. 25, of pneumonia. Mr. Gould was born in New York City in 1837 and was educated by private tutors and private schools and at the Ecole des Mines, St. Etienne, France. He began the practice of civil engineering in 1865. In 1872-76 he was Assistant Engineer, U. S. Corps of Engineers; 1879-86, Assistant Engineer Croton Aqueduct, and Division Engineer New Croton Aqueduct. In 1886-90 he was engaged on construction of Scranton, Pa., water-works. One of the most notable of his undertakings was the construction of water-works for Havana, Cuba. He was the author of several scientific books. A fuller obituary notice of Mr. Gould will be given in a succeeding issue.

ENGINEERING SOCIETIES.

COMING MEETINGS.

STATE AND LOCAL BOARDS OF HEALTH OF OHIO.
Jan. 27, 28, 1905. Annual meeting at Columbus, O.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Jan. 30 to Feb. 11, 1905. Annual meeting at Birmingham, Ala.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 28, 1905. Annual meeting at Toronto, Ont. Secy., Killaly Gamble, Temple Bldg., Toronto.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 21, 22, 23. Annual meeting at Chicago. Secy., L. C. Fritch, 1562 Monadnock Block, Chicago.

WEST VIRGINIA ENGINEERS.—Mr. Henry Mace Payne, Civil Engineer, White Bldg., Williamson, W. Va., is actively seeking to form an organization of engineers from southern West Virginia and the neighboring parts of Ohio and Kentucky. All engineers in that district who would be interested in a local engineering society are urged to communicate with Mr. Payne.

NEW YORK RAILROAD CLUB.—At the regular meeting of Jan. 20, 1905, held at 154 W. 57th St., New York City, Mr. W. B. Potter presented a paper entitled "Developments in Electric Traction." An interesting general view of the subject was presented, illustrated by the locomotives built for the B. & O. and New York Central Railways, the new alternating-current car on the Ballston interurban line, and a gasoline-electric motor car for railway use, now being built by the General Electric Co. The attendance was very large, and included many notabilities in railway and electric work. The discussion was carried on by Mr. F. J. Sprague, Mr. W. J. Wilgus, Mr. B. J. Arnold, Mr. B. G. Lamme, Mr. J. G. White and others. We expect to give an abstract of the paper and discussion in our next issue.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—At the next meeting at New York City, to be held at 154 W. 57th St. on the evening of Jan. 27, two papers will be read: "Acyclic Dynamos," by Mr. J. E. Noeggerath, and "The New Turbo-Generator Station of the Edison Electric Illuminating Company of Boston," by Mr. J. E. Moultrop. The annual dinner of the Institute will be held at the Waldorf-Astoria Hotel, New York City, on the evening of Feb. 8, 1905. Electric railway development will be featured in the decorations and speeches.

The Seattle branch held its annual meeting and banquet at the Maison Berberis, Seattle, Wash., on Jan. 14, 1905. Major Russell, of the Signal Corps, U. S. A., gave an informal talk on the work of laying the submarine cable between Seattle and Sitka, Alaska. The branch pledged itself to contribute $100 a year for five years to the building fund.

NEW YORK ELECTRICAL SOCIETY.—At the regular meeting held on Wednesday evening, Jan. 18, 1905, at 19 W. 44th St., New York City, Prof. W. S. Franklin, of Lehigh University, lectured on "Electric Waves and the Reaction of Transmission Lines." The main portion of the lecture was an exposition of the theory of electric and magnetic fields in the ether by the aid of the "cellular" theory of ether structure. This theory was explained as premising rotatable ultimate particles connected together elastically; electric stress is represented by a separation of positive and negative particles, while magnetization is represented by a rotation of the particles on the axis of the lines of force. The elastic connection results in a correspondence of varying electric field with a varying magnetic field, and in the case of a disturbance results in the propagation of electric and magnetic waves. Basing on this explanation, the lecturer stated in brief the manner of propagation of an electric wave along a wire, and the influence upon it of line-resistance and line-leakage. He illustrated the distorting and attenuating effects of these factors, and explained how the distorting effects of the two factors could be balanced against each other. By raising the active potential, and thereby reducing the current for given energy, the attenuation itself may be reduced. The principal discussion was by Prof. M. I. Pupin, who objected to Prof. Franklin's procedure from a pedagogic standpoint. In his opinion the lecturer attacked the subject from the most abstruse end as starting-point, reversing the usual and natural course. This led to the reply that while the single wave-disturbance may be the most difficult part of the subject on the mathematical side,

it is the simplest on the physical side, simpler than the continued or periodic wave. The lecture was illustrated by numerous slides, showing diagrams of the hypothetical actions which were expounded. Secy., G. H. Guy.

ANNUAL MEETING IOWA ENGINEERING SOCIETY.—The seventeenth annual meeting of the Iowa Engineering Society, convened in the Auditorium of the Liberal Arts building of the State University of Iowa, at Iowa City, at 2 p. m., Wednesday, Jan. 11, 1905. Addresses of welcome were given on behalf of the city by the mayor, F. K. Stebbins, and on behalf of the State University by President George E. MacLean. The meeting comprised six sessions, closing Friday afternoon. Papers were read: By L. E. Ashbaugh, on "Topographical Survey of Meandered Lake Beds"; by Geo. M. Thompson, on "Assessing Cost in Drainage Districts"; by J. J. Ryan, on "Rebuilding the Muscatine Water-Works"; by J. M. Brown, on "C. R. I. & P. R. R. Shops at Moline, Illinois," illustrated by photographs showing progress of the work; by Prof. Wm. G. Raymond, on "Capacity of Flowing Streams for Power Without Storage," illustrated by lantern slide diagrams; by Prof. S. M. Woodward, on "Power of Running Streams as Affected by Flood"; by Chas. P. Chase on "Inaugurating Sewer Work and Some Defects in the Iowa Sewer Laws"; by W. L. Breckinridge on "Track Revision on C., B. & Q. R. R."; by Dr. Henry Albert on "The Bacteriological Examination of Water as it Concerns the Sanitary Engineer," illustrated by charts and an exhibit of apparatus; by L. H. Stone on "Sewerage System of Des Moines"; by R. B. Slippy on "Municipal Engineering for Small Towns"; by C. T. Wilson on "Water Problem in a City of 18,000 People"; by C. A. Baughman on "The Marshalltown Reservoir"; by Chas. P. Chase on "Cement and Concrete Construction," being hints on the subject suggested by practice; by Prof. C. S. Magowan on "Iowa Avenue Culvert, Iowa City," a piece of reinforced concrete construction, illustrated by lantern slides; by B. J. Lambert on "Concrete Dam at Manchester, Iowa"; by J. B. Marsh on "Concrete-Steel Bridge at Kankakee, Illinois" by C. A. Baughman on "Cost of Relaying Brick Pavement with Cement Filler"; and by C. R. Allen on "Land Surveys." The report of the committee on Special Legislation showed that the committee had succeeded in getting the last legislature to pass a bill enabling towns and cities of the second class to vote double the amount that they could formerly vote for the construction of water-works and sewers. The report of the committee on Roads and Pavements outlined the work of the State Highway Commission at Iowa State College. The committee on Iowa Elevations reported that it is endeavoring to get all levels in the state referred to a common datum plane. The report of the secretary, Mr. A. J. Cox, showed that the society has a membership of 90 and a cash balance of about $100.

The election of officers resulted as follows: President, Mr. J. D. Wardle, of Cedar Rapids; Vice-President, Mr. L. E. Ashbaugh, of Ames; Secretary and Treasurer, Mr. B. J. Lambert, of Iowa City; Directors, Messrs. W. H. Jackson, of Des Moines, and A. J. Cox, of Iowa City.

ANNUAL MEETING AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.—The eleventh annual meeting of the American Society of Heating and Ventilating Engineers was held at the Hotel Astor, New York City, on Tuesday to Thursday, Jan. 17 to 19, 1905. The meeting comprised four sessions, which, with the exception of routine business, were devoted to the discussion of technical papers and topics. The annual dinner, on the evening of Jan. 18, was the only "outside" event of the meeting.

The election of officers, which is the only business item calling for record here, resulted in the choice of the following: President, Prof. William Kent, of Syracuse, N. Y.; Vice-Presidents, Messrs. R. P. Bolton and C. B. J. Snyder, both of New York City; Secretary (continued), Mr. W. M. Mackay, of New York City; Treasurer, Mr. U. G. Scollay, of New York City; Governors, Messrs. B. H. Carpenter, of Wilkesbarre, Pa., B. F. Stangland, of New York City, James Mackay, of Chicago, Ill., A. B. Franklin, of Boston, Mass., and J. C. F. Trachsel, of Philadelphia, Pa.

The papers and discussions are abstracted in the following:

Mr. J. A. Donnelly (New York, N. Y.) read a paper on "Appliances and Results in Exhaust Steam Circulation." This paper described two auxiliary devices of special design, for use in heating systems employing exhaust steam. The first is an automatic valve for removing air and water, draining the radiators into the main return. It is a small counterweighted flap-valve, having a very small permanent opening through which air and steam can flow; when water collects and reaches the valve it strikes the flap with sufficient force to hold it part open until all water has passed through. The other device is a pressure-controlling valve, of the diaphragm type, which maintains a fixed (but adjustable) difference of pressure between the supply main and the branch return. Several heating installations are then described where these devices, and special arrangements looking toward economy, were successfully employed. The author stated that the special purpose of these devices is to make it possible to have considerable lifts in the return pipes at long distances from the condenser; but Mr. Warren Webster (Camden, N. J.) reported that without any device of this kind he had successfully operated a 16-ft. lift in the return pipe at 1,600 ft. distance from the pump.

An interesting paper entitled "Investigation of the Accuracy of a Direct-Reading Hygrometer" was contributed by Prof. R. C. Carpenter (Ithaca, N. Y.). It contains a short description of the various kinds of hygrometers or psychrometers (the words have no definite distinction) and reprints a condensed table for interpreting the readings of a standard Sling Psychrometer such as is used by the U. S. Weather Bureau. The direct-reading instrument tested was a low-priced instrument having a pointer actuated by a steel spiral like a watch-spring on whose inner surface is pasted a silk ribbon. It was found that two different instruments of this type, compared with readings obtained from a sling psychrometer, gave readings incorrect by from 2 to 5% of saturation, the error depending somewhat on the temperature. The author concludes that instruments of this kind, when once calibrated to determine their error roughly, are satisfactory for use in the home or by heating engineers, but can not be used for accurate work. It was found that the error of the instrument did not change materially within a year.

A general discussion on Moisture in Heated Houses developed from this paper. Prof. Carpenter contributed the following observations: During the first half of the present winter his house at Ithaca, N. Y., heated by steam radiation, has shown a humidity of 18 to 35%, averaging near to 25%; the temperature was quite constant at about 70-73° F. During the same period the outside atmosphere ranged in humidity from 60 to 80%, averaging 70%. The air in his house, Prof. Carpenter concluded, is "extremely dry, drier than the air of most deserts." The general discussion showed little uniformity or even definiteness of opinion as to what degree of humidity is desirable in houses, or how it may or should be controlled. Mr. W. T. Donnelly (New York) held that humidity alone is not a determining factor, outside of temperature, in determining the effect of air on persons; he cited the names "March air," "September air," "morning air," as denoting something beyond humidity or temperature effects. Mr. A. M. Feldman (New York) quoted observations on humidity in heated houses, reported by Dr. H. M. Smith to the Brooklyn Medical Society some time ago. The figures agreed closely with those reported by Prof. Carpenter, and the observations also tend to show that 60% moisture should be considered desirable in heated houses; a room at 65-68° F. with 60% humidity was found (by observers ignorant of the temperature or humidity of the rooms) to be more comfortable and several degrees "warmer" than a room at 72 to 73° F. with but 30% moisture.

"Gas as a Fuel for Hot-Air Heating," as presented by Mr. R. S. Thompson. The author proved to be extremely optimistic about gas heating; he begins his paper thus:

> I believe the day is not far distant when the householder would no more think of filling his cellar with coal in order to supply his house with heat than he would of putting a slaughter-house in his cellar in order to supply his family with meat.

But in the past, he says, attempts at using gas fuel in hot-air furnaces have failed because it was attempted to burn gas in a coal furnace, whereas the requirements for gas are radically different from those for coal. The points to be observed are: (1) a proper burner; (2) proper heating-surface, far more than required in a coal-furnace; (3) active air-circulation; (4) means for taking care of the water of condensation from the flue-gasses. The burner should be such as to permit each flame to be surrounded with fresh air, in addition to having fresh air introduced at the mixer; it is impossible to secure complete combustion if air is introduced at the mixer only. The temperature of the flame and of the entire interior of the furnace is much lower than in coal-furnaces, hence proportionately larger heating-surface must be provided. As the air heated will then also be cooler than in a coal-furnace, more air is required to heat a room; that is, the air circulation must be more active. This is best provided for by using returns for taking the cold air from each room back to the furnace. The water produced by the combustion of the hydrogen in the gas will in part condense in flues and chimney, and must be suitably drained off. Further, as any sulphur in the gas will make this water acid, it is better to line the chimney with tile pipe.

In discussion, Prof. R. C. Carpenter remarked that natural gas is often hard to burn smokelessly, especially when products of the combustion are allowed to surround the flame. Again, when too much air is supplied, the flame is cooled off so much that only the hydrogen burns, leaving the carbon as soot. However, such imperfect combustion does not produce carbon monoxide, as the author claimed. Prof. Wm. Kent suggested that a high fire-pot temperature could be attained by placing suitable fire-brick in the path of the flame, in order that the fire-brick may be heated to a high temperature and radiate heat as does the bed of coal in a coal-furnace. Mr. Wm. T. Donnelly, reported that in developing a line of gas water-heaters for kitchen use he had been able to obtain very high efficiencies. With 2¼ sq. ft. of copper coil heating surface, and burning 2½ cu. ft. of gas per hr., no less than 70 to 75% of the heat of the gas is transferred to the water; the combustion in such heaters is very complete, no smell of gas being perceptible. He has found it absolutely essential in such devices, to secure complete combustion, that each flame be surrounded by pure air instead of having the flames so close together that they coalesce. He suggested that for house-heating purposes it might prove better than air-heating if the gas were utilized to heat water and the latter used either for direct circulation or else for heating air to be circulated.

In a paper on "Steam Heating in Connection with Condensing Engines," Mr. R. P. Bolton (New York, N. Y.) suggested the possibility of heating by the exhaust steam from condensing engines, by interposing the heating coils in the exhaust pipe, that is discharging the exhaust steam into the heating main and attaching the condenser to the return. The available temperatures, for economical degrees of vacuum, will be so low that additional heat will be required in cold weather, and the proper method of introducing this additional heat requires careful study for its determination.

Prof. Wm. Kent stated that the suggested system appears very attractive; it should prove economical and flexible, but would require careful attention to keep the vacuum regulated. Prof. R. C. Carpenter remarked that he has installed a system just as described except that the coils were disposed to heat a hot-air blast for heating, instead of radiating direct. But that installation has not been used as intended for the reason that the non-condensing engine in the plant in question has never been replaced by a condensing engine; the system is now used as an ordinary non-condensing exhaust heating system. It was objected by several speakers that the maintenance of the heating piping, in Mr. Bolton's system, tight enough to carry a reasonable vacuum, would be impracticably difficult in view of the fact that even a short exhaust pipe usually leaks enough air to pull down the vacuum an inch or two.

A note on "Experience with Radiators in the Top Story of a Building," by Mr. A. B. Reck, of Copenhagen, Denmark, called attention to the fact that if radiators in the top story of a building are proportioned only for window and wall area, like those of other floors, trouble may arise from the ceiling radiation, which requires an extra allowance of heating surface in an amount depending upon whether there is an attic over the ceiling or merely the ordinary roof with shallow air-space.

Mr. J. S. Brennan (Milwaukee, Wis.) in a paper entitled "The Circulation of Hot Water," described a new form of radiator and connecting fitting, which has only one pipe attachment to the radiator itself, the supply and return pipes being attached to the fitting below the floor. The radiator shown is devised to secure more thorough water circulation than the usual style.

"European Methods of Heating Fifty Years Ago" was the subject of a paper by Prof. R. C. Carpenter (Ithaca, N. Y.). The author showed that progress in heating work during the last seventy-five years or more has been in the direction of spreading and cheapening central heating, and in standardizing the appliances and materials, but has not included any marked advance in the data or principles available to the heating engineer.

Tredgold's book on the subject, first published in 1824 and reissued in 1836, describes steam-heating which even in its detail appliances is substantially the same that is in use to-day. But in those days there were no standard pipes, couplings, valves, radiators, etc., etc., and the heating contractor had to build them for the special case. It is the progress in developing the manufacture of these parts, a progress in which Americans took the lead, that constitutes the main point of advance in central heating in the last half century. The paper gave an excellent review of some of the earlier publications on heating. Some supplementary information was contributed by Mr. H. J. Barron (New York) in discussion.

In addition to the papers, several topical questions were discussed, but little of permanent value was brought out. One of the topics, dealing with hot-air furnaces, led to the decision that a committee should be appointed to collect and compile information on current practice in hot-air furnace work. Messrs. F. K. Chew, Wm. Kent, and C. B. Oldacre were appointed to constitute this committee.

The report of the Committee on Tests brought forth an interesting item of information from its chairman, Prof. R. C. Carpenter. He had occasion during the past year to test a heating boiler (steam) and determine its performance. It turned out that the general impression that heating boilers are much less efficient than ordinary power boilers, is erroneous. The boiler was tested at two rates of combustion, respectively, 3.8 and 5.2 lbs. coal per sq. ft. of grate surface per hour. The performances were respectively 10.48 and 10.28 lbs. water evaporated per pound of coal from and at 212°, which compares well with the best power-boiler performances. The ratio of heating to grate surface in this boiler was 25, with 12% of superheating surface. On the standard basis of 34 lbs. per hour, the boiler developed 6 to 9.7 HP. The flue-temperatures in the two tests were 318 and 320° F. As tests of cast iron radiators show that they usually condense a little less than ¼-lb. steam per hour, the radiating surface required for a given boiler may be found by multiplying its evaporation in pounds per hour by four.